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Contents

	PAGE.
"Odd Shillings and Pence"	19
A Commendable Scheme	19
The Manufacture in the Electric Furnace of Shock-Resisting Cast Iron	20
Book Review	20
Cast Iron and Motor Cars	20
London Foundrymen's Visit to Belgium	20
Rammed Refractory Materials	21
Catalogue Received	23, 32
West Yorkshire Foundrymen Discuss Tolerances	23
Publication Received	23
East Midlands Foundrymen Discuss Patterns	24
Developments in the Production of Ingot-Mould Castings	25
Estimating for the Foundry	28
Notes from the Branches	32
The Week's News in Brief	34
Trade Talk	34
Contracts Open	34
New Companies	34
Company Meeting	34
Personal	34
Obituary	34
Forthcoming Events	34
Raw Material Markets	36
Company Reports	36

"Odd Shillings and Pence"

Between January 7 and 20, extensive efforts are being made to interest the public in the "Odd shillings and pence" appeal which the Lord Mayor of London is launching on behalf of the King George V National Memorial Fund. During the period, January 14 to 20, known as the King George Memorial Week, an appeal is being made to members of the public to sign the special transfer forms which will be published every day in every national and provincial newspaper instructing their bankers to transfer to the Memorial Fund the odd shillings and pence in their account, whether credit or debit, on the night of January 20, the anniversary of King George's death. In order to enable everyone to participate in the scheme in one form or another, special forms adapted to the conditions of the Post Office Savings Bank will be in every Post Office where Savings Bank business is transacted, while special forms will also be available at building societies and trustee savings banks. In addition, the Alexandra Rose Day organisation and similar bodies will distribute transfer forms from house to house, and in all it is calculated that some 150,000,000 forms will be printed.

The sum of money thus raised will be devoted entirely to providing playing fields in towns and villages throughout the country. The appeal for the Westminster statue memorial has closed, a sum of £125,000 having been allocated for this purpose. At present there are some £250,000 available for the playing fields memorial, and whatever sum is yielded by the "Odd shillings and pence" appeal will be added to this existing fund. The whole of the playing fields fund will be handed over in due course to the King George's Fields Foundation, and applied towards supplementing all schemes for providing playing fields that meet with the conditions drawn up by the Trustees, and such fields will be marked by means of an entrance gateway that will for all time proclaim them "King George's Fields." Memorial panels will appear on these gateways, and designs for these panels are now being considered by the Trustees and the Royal Fine Art Commission.

We commend this deserving appeal to the generosity of our readers, and trust that each and all, not having already contributed, will help to make this effort an unqualified success.

A Commendable Scheme

Last week we had the opportunity of inspecting the Army Vocational Training Centre at Aldershot, and were distinctly impressed with the intelligent organisation of the work. The courses are available to soldiers within six months of taking their discharge, and they pay a minimum of 5s. a week for a private up to 10s. or so for a sergeant major. We definitely approve of this action, in spite of the arguments put forward that the unemployed receive their training free of charge, as it ensures that the trainees are definitely keen to learn a trade. The next fact is that only trades are taught which do not require a long apprenticeship, such as loam moulding or blacksmithing, but rather is attention confined to welding, bricklaying, plastering, boot-making, painting and paperhanging, plumbing and the like. For some of the trades taught—welding is one of them—the supply of trained men is insufficient to meet the demand, and in general an 85 per cent. success in placing the men is recorded. Naturally, restrictive conditions, such as a desire to follow a vocation in their own village, mitigates against a still higher percentage being placed. The work undertaken is severely practical, and villa property is built adjacent to the Centre wholly by the students. The instructors are entirely drawn from civilian sources, and they are specially chosen for their highly developed craftsmanship and ability to instruct. The shops are run under works conditions, and contracts from the Army stores department enable a certain amount of quantity production work to be undertaken. This provides a revenue for the purchase of new plant.

To our mind, it is for the good of the country that a man who has served his country well for seven years should not be penalised in after-life by unemployment, and manufacturers should do everything in their power to support such a common sense activity as is exemplified by this training centre, which is one of several. We believe that certain of the foundry employers' associations would do well to send a delegation to Aldershot to see if a foundry could not be usefully grafted on to the Centre, where at least repetition moulding and light coremaking could be taught. We can, from testimonials we have inspected, and from the general keenness displayed upon the faces of the trainees, state that recruits to industry so obtained would be a distinct asset to a firm's working force.

The Manufacture in the Electric Furnace of Shock-Resisting Cast Iron*

The cupola is the most economical method for the melting of cast iron, but it is ill adapted for refining purposes. The electric furnace, operated in conjunction with the cupola, is, however, well suited for the manufacture of high-quality metal. The electric furnace which gives the best results from the industrial angle is of the three-phase type, basic-lined with either magnesite or dolomite.

Manufacture of Piston Rings

The following compositions are suggested: (*a*) for thicknesses from 10 to 12 mm.:—T.C, 3 to 3.1; Mn, 0.4 to 0.5; Si, 2.2 to 2.3; S, 0.05 (max.), and P, 0.10 (max.), and (*b*) for thicknesses from 15 to 18 mm.: Si, 2.05 to 2.15.

The Duplex Process

To make a ton of iron, teem into the furnace 930 kgs. of good hot liquid iron from the cupola; cover the bath with 12 kgs. of pea-sized powdered charcoal and then add 1 part of the desulphurising and deoxidising mixture to the bath and turn on the current. Ten minutes later add the rest of the mixture. When the slag has formed and has attained a greyish white colour, add 80 kgs. of clean, rust-free, small sized steel scrap. Ten minutes later everything should be melted, and a spoon sample should be taken if the metal is well deoxidised. If the desired degree of hardness is not shown a compositional correction is made at this point. The duration of the operation as far as this stage should take from 60 to 70 minutes.

In order to obtain a material showing a high resistance to shock it is essential to cover the bath with charcoal before adding the desulphurising and deoxidising mixture. The composition of this mixture for each ton of iron is: lime, 11 kgs.; fluorspar, 5 kgs., and coke, 2 kgs. It must take the form of a well-mixed, finely ground powder. The cast iron so made will show shock-resistance figures of about double those to be associated with ordinary cupola-melted iron. To obtain a material of still higher shock resistance it is necessary to make an addition of nickel and chromium or compound the iron by starting from turnings if the price of current is not too high.

Iron from Turnings

To obtain 1 ton of cast iron, charge into a very hot furnace 1,030 kgs. scrap, 30 kgs. lime and 20 kgs. iron ore placed on the banks of the furnace. After about 1½ hours the bath should consist of strongly heated dead mild steel. After a preliminary slagging the current is cut off and every trace of slag is removed. To the bare surface of the bath about 10 kgs. of pea-sized anthracite is added. Current is switched on, and about every five minutes fresh additions of anthracite are made to replace that absorbed and burnt, until 55 kgs. have been added, which should represent about 3 per cent. of the iron. This figure is controlled by taking spoon samples and ascertaining their composition from the laboratory. If the desired carbon content is reached the current is switched off and the bath is completely slagged. After slagging add 30 kgs. of 75 per cent ferro-silicon and half the deoxidising and de-sulphurising mixture; then switch on the current. Ten minutes later charge in the balance of the mixture. When the colour of the slag shows that the metal is thoroughly de-oxidised, take a sample and if the desired degree of hardness is reached, cast.

Length of Operation

Melting, 1 hr. 50 min.
Recarburising, 50 min.
De-oxidation, 50 min.
Total about 3½ hrs.

* Extracted from the "Journal de Fours Electriques"

The de-oxidising mixture is the same as was referred to above. This type of iron carries a shock-resisting figure about 50 per cent. higher than that obtained with irons made by the Duplex system.

For comparison the cost prices of a ton of iron manufactured by various processes are given in francs: (*a*) Cupola, 475. (*b*) Duplex system, 565. (*c*) Starting from cold charges, 575.

Conclusions

Comparisons made between the cost price and the shock-resisting properties obtained by the various processes reveal that the Duplex system in spite of its heavy cost is of distinct interest, as well as the cold-charge process which can only be used by foundries having available cheap electric current.

Book Review

Metallurgie. By R. CAZAUD. Published by Dunod, Paris. Price 20 fcs.

Designed for the use of engineers and those concerned with the production and use of the ferrous and non-ferrous metals, this little book is one of a number issued by the same publishers under the general title of "Agendas Dunod." It may be said at once that the general impression gained by this particular item is sufficiently favourable to make the reader look forward with pleasure to the possession of the remainder.

The book is divided into five sections, the first dealing with fuels, fluxes, refractories, and furnaces for solid, liquid, and gaseous fuels. A special sub-section is devoted to electric furnaces of various types. In the compass of fifty pages it is doubtful whether a more comprehensive survey or a better chosen array of tables and line-drawings appropriate to the subject could have been made. The ten pages dealing with electric furnaces are very detailed, save in respect of high-frequency furnaces which are disposed of in about fifteen lines.

Pages 53 to 98 are devoted to mechanical testing of every type, and include tables which serve to give a fair idea of properties to be expected from various alloys. In common with similar tables given in publications of this type, those contained in this book might constitute a source of misleading information in the hands of a reader unaware of the effects of structure on mechanical properties. Since, however, the book does not claim to be a complete text-book on the subject this is of relatively minor importance.

Those who have grappled with the more complicated equilibrium diagrams may be surprised to find the whole subject glossed over in six pages, of which total, ternary systems, with no assistance in the shape of sketches of any kind, must be satisfied with less than two hundred words. The succeeding pages on corrosion testing are a welcome discovery, being well written, accurate, and dealing with a subject not commonly found in manuals of this kind. Section 2 closes with a brief account of the technique and significance of the micro- and macro-examination of metals and alloys.

Section 3 is contained in fifty pages and deals reasonably fully with the theory and practice of heat-treatment of ferrous and non-ferrous metals, including cementation of steel by means of other metals.

A surprising wealth of detail is contained in the pages dealing with the metallurgy of iron, no points of value are omitted, and the survey is completed by the inclusion of some useful production statistics. The section devoted to the metallurgy of the non-ferrous metals is somewhat compressed in detail. As a typical example of an omission, in the article on magnesium, no mention is made of the foundry technique developed for this metal, and in connection with

(*Concluded in next column.*)

Cast Iron and Motor Cars

MR. R. CHAVY, writing in "La Fonte," stated that in an average touring car, the weight of which is about 16 to 24 cwts., the total weight of grey iron castings, not including malleable, is of the order of 220 to 264 lbs. Unquestionably the proportion is still greater in heavy vehicles, where the quantity of unmachined grey iron castings per chassis may reach 6 to 10 cwts.

The importance of grey iron castings used in the motor vehicle industry is obviously of considerable consequence. The author has set down, in the following terms, the technical and economic advantages of this metal:—

(1) The great "life" of the grey iron permits of the easy production of sound castings, even though they be of a very complicated shape.

(2) The cost price is generally considerably lower than that of the same components when made as either steel forgings or weldings.

(3) Frictional properties are in general distinctly superior to either ordinary or special steels, this superiority being due to the presence of graphite flakes.

(4) The relatively low modulus of elasticity allows the castings easily to take care of deformations of known amplitude set up by thermal expansion (cylinder heads, exhaust boxes, etc.).

(5) A capacity for absorbing vibrations (mechanical hysteresis). This property being distinctly superior to steel, and it constitutes for certain castings, such as crankshafts, a really important advantage.

(6) Cast iron is not liable to any deleterious effect emanating from notching, as is shown by alternating stress testing.

The properties demanded of the various cast-iron castings for an automobile chassis are very diverse, according to the duties expected from them.

The author has separately studied each casting, and has shown the characteristics desired and the varieties of irons used for their manufacture. He has pointed out the spheres for the use of the special irons which have been developed and which can increase the hardness of the castings (cylinder castings in nickel chrome cast iron; gear box cases in Ni-Resist or in chrome-molybdenum cast iron).

London Foundrymen's Visit to Belgium

With the acceptance of a cordial invitation issued by Mr. Paul Ropsy, of the Société Belge Griffin, the programme printed in our last issue is now complete. The work carried on at this foundry is of a unique character, as it specialises in the production of chilled iron castings destined for uses not normally encountered in Great Britain. This visit is to take place on the morning of March 18.

(*Concluded from previous column.*)

its extraction, the process of thermal reduction and distillation is entirely passed over, in spite of the challenge which this method extends to the electrolytic extraction processes.

Those pages devoted to brief descriptions of the less common metals are free at least from the grosser omissions and inaccuracies so often found in booklets of this type.

The publishers are to be congratulated upon the production of an excellent handbook by an author who may claim to have achieved no small task in compressing so much useful matter in so little space.

W. N. J.

Rammed Refractory Materials*

By M. MUGNEROT

Qualities Required

The question primarily affecting the production of linings of rammed refractory materials concerns in the first place the constancy of volume at all times during service. Mechanical strength and refractoriness are also factors which have to be taken into consideration.

Generally speaking, the object sought is to produce a construction having the properties of masonry built with refractory bricks, and in view of the absence of joints, a rammed refractory material is expected to possess the abovementioned constancy of volume, not to become disintegrated in the course of the mechanical channelling caused by the pig-iron and scrap, and finally to be sufficiently refractory to withstand the melting of metals at 1,575 deg. C., in other words, to be able to withstand temperatures of at least 1,750 deg. C.

Constancy of Volume

The increase in volume is caused by the expansion of the quartz under the action of temperature. Investigations on the transformation of the various modifications of silica are somewhat complicated, and it is not the purpose of this Paper to discuss this, but rather to state it as a fact and to show how such expansion may be obviated. The author has made a special study of the transformation of silica, because being the originator of the regeneration of used foundry sand by means of clay, it was necessary for him to observe what became of the quartz in synthetic moulding sands during the course of repeated use. Before discussing the state of quartz in such sands and siliceous ramming materials, it is necessary to consider the final state and all the intermediate states of silica.

True silica is quartz, but in the anhydrous state the latter occurs in numerous varieties. Technicians are more concerned with the intermediate states of transformation of this anhydrous silica into trydimite and crystobalite. Crystobalite gives rise to a modification in density of the quartz varying from 2.27 to 2.35 and trydimite to a density of 2.20 to 2.45. It is found, however, that transparent crystobalites may have a density of 2.45 and likewise trydimites sometimes have a density of 2.50. The author has endeavoured to define the innumerable intermediate states from the point of view of crystallographic equilibrium rather than from that of chemical composition, because he considers that even quartz may give rise to an incalculable number of densities when used in the foundry, according to its state of transformation.

The expansion of quartz commences at 550 deg. C. As shown in Fig. 1, the expansion does not proceed regularly. In some cases the crystallographic equilibrium may be suddenly upset if the temperature throughout the mass of quartz is not uniform. This will occur more frequently with some kinds of quartz than with others, and splitting may take place along the crystallographic base planes and cleavage planes. Trydimite results from a final condition of the quartz, and, as already stated, is accompanied by a lowering of the density. The production of crystobalite takes place at 1,200 deg. C. Its final expansion, therefore, necessarily results in a diminution in density.

Trydimitic Modification Preferable

It is essential to know all the conditions of these siliceous materials employed in foundry practice, and it has been found that trydimite is preferable to crystobalite. It may be stated, however, that it is by no means possible to discriminate between all the states through which the silica of foundry sand passes in the course of casting. It was endeavoured to ascertain the disadvantages which might result from the use of spent sands, and information on this point could only be obtained by carrying the regeneration of foundry sands to the extreme limit. The investigations which have been made into the various forms of quartz and silica in general and the numerous allotropic forms have complicated the problem to such an extent from the point of view of foundry practice, that, although they may be assumed to be worthy of attention from the technical point of view, they may be ignored in the actual study of foundry sands and ramming materials.

The various fluxes which may be present in silica considerably modify the rate of transformation of the different states of silica, and it is impossible to recognise laboratory operations in the practical use of rammed materials. It must also be borne in mind that silica is subject to reversible transformations and the formation of crystobalite will be promoted by the influence

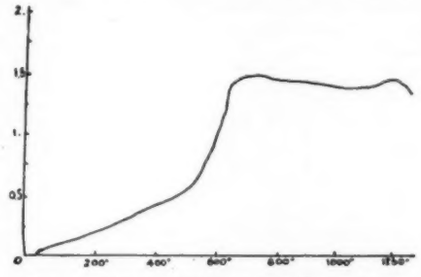


FIG. 1.—GRAPH SHOWING THE EXPANSION OF QUARTZ.

of mineralising agents, such as the lime contained in rammed materials, alumina between 5 and 9 per cent., potash and soda.

Rotary Furnace Linings

Conversely, there may be reduction in volume of the rammed refractory material due to the contraction of the alumina. This phenomenon of the reduction in volume is met with in some excessively aluminous linings of rotary furnaces. The refractory lining becomes detached from the body of the furnace and drops off during the melting operation. Or the metal finds its way through the cracks, melts the lining and casing of the furnace and escapes. Argillaceous products undergo a first shrinkage on drying, and later a second and final shrinkage resulting from the loss of water of crystallisation during burning. The first shrinkage is not important with regard to linings, but the shrinkage on burning, or more correctly on fritting, is of great importance. It would appear that shrinkage on burning is the result of an advanced vitrification at a low temperature (from 700 deg. C.) of the prismatic particles of clay, and it has been found that the more amorphous molecular forms of clay give rise to less shrinkage. In other words, it is always more difficult to expel the combined water from prismatic forms of clay than from amorphous forms. By definition, crystalline forms of clay contain more water than amorphous forms, and shrinkage is more intense in the former case. This can easily be shown by introducing powdered mica in a clay which will then give a greater shrinkage than when it is not mixed with mica.

Contraction Allowances

Investigation of the compensation of the variation in volume gives a tolerance of 2 per cent. more or less of alumina, and also shows that a well-defined particle size is necessary. In practice, rammed materials are employed for linings having compensated false joints. Wooden laths may be placed against the metal casing at intervals of about 1 in. Owing to the cuts made in the corners, the compensated joints may allow metal to enter the lining, and this metal, being subsequently converted into iron oxide, will facilitate the destruction of the lining by penetration. The wooden laths may be burned. These two methods of compensating the variation in volume ought to be obviated by consideration of the crystallographic equilibrium and the alumina content.

The normal equilibrium of a rammed material depends mainly upon the state of fineness of the siliceous portion of the material and upon the alumina content, which varies from 6 to 8 per cent. If the state of fineness of the siliceous portion of the material and the percentage of alumina are not capable of providing constant volume, it is possible to add fireclay containing 42 per cent. of alumina, dead burnt in a gas-fired furnace but not in a melting furnace, and crushed to a fineness index of 50.

Expansion Force

Apart from the refractory characteristics, the study of the compensation of the variation of volume of rammed material has attracted the attention of furnacemen rather than that of the manufacturers, and in this connection it is necessary to be very circumspect when marketing rammed materials if a guarantee of constancy of volume has to be given. The author once witnessed in a steelworks the fracture of 48 bolts used for assembling the conical part of a furnace with the cylindrical part. These bolts had a diameter of 8 to 10 in. and their tensile strength corresponded to a force of 1,500 tons. Other more serious accidents were produced, due to the fact that the separation of the casing took place during melting when the metal had a temperature of 1,500 deg. C.

By radiation, a lining of rammed material 12½ in. thick in a 5-ton furnace attains 870 deg. C. at least 4 in. from the surface of the material in contact with the metal, and if this temperature exceeds 1,470 deg. C., the point of transformation of trydimite into crystobalite, there will be maximum expansion. At the Citroën works the author has seen a cupola with receiver, the whole weighing 600 tons, together with the charging skip, lifted 1.6 in. The area on which the receiver was supported on the ground was about 20 sq. ft.

Mixing for Use

When considering the compensation for the variation in volume, it is necessary to ascertain the nature of the silica which, in view of the refractory character, should be present as far as possible in the form of quartz rather than silicates. Furthermore, the material should be screened, the fineness should be 60, and the alumina content should be 6 to 8 per cent., and also, if the material contains lime or other foreign matter capable of activating the transformation into crystobalite, it is necessary to add a quantity of dead-burnt fireclay containing 42 per cent. of alumina and of a fineness of 50 in amounts of 6 to 10 per cent. These ramming materials are raw materials intended for the production of refractory linings as well as for running repairs, and are used as follow:—

The material is supplied in the dried and crushed state, if possible in sacks, and is spread out on a very clean surface, preferably concreted. The material is moistened with about 3 or 4 per cent. of water in a thickness of 2¾ or 3 in., more dried material is added, the mixture is again sprinkled with water and is left to stand for several days. It is then turned over with a spade, and after eight days of moistening the material is ready for use. The amount of water added for optimum conditions of use should be such that the material retains its granular consistency, but never assumes that of

* A Paper read before the Syndicat des Fabricants de Produits Réfractaires de France

a mortar. The percentage of water required by the ramming material obviously depends upon its degree of fineness and the quality of its clay, but the material when properly prepared should not stick to the hands and when ready for use should behave like a foundry sand.

The lining of converters and all kinds of furnaces is made by using a wooden or sheet metal template having a detachable part to enable it to be withdrawn easily after the lining has been placed in position. If the template is of sheet metal, it is arranged to be unbolted so that it may be removed after use and can be used indefinitely. In other cases, very light wooden formers are used and these remain in the furnace and are burnt.

A Novel Method Disclosed

In 1930 the author was successful in making the lining of large pulverised fuel fired rotary furnaces without using a template. Furnace constructors, however, recommend their use. The furnaces have then to be set on end and very powerful cranes are required, since some furnaces of 5 tons capacity necessitate a lining of rammed material weighing 50 to 60 tons.

This method has been replaced by a horizontal method of ramming furnace linings. The horizontal furnace is left on its rollers and a boundary partition of the thickness of the lining to be applied is fixed along the inside of the furnace. This is done in a very simple manner by driving steel spikes into the lining to serve as supports for planks set up on edge. This forms a barrier and ramming is commenced by means of a compressed air rammer which is held at a slight inclination in order to accentuate the pressure towards the plank. The furnace is not even cleaned out before ramming the new lining, because the slag, small hollows, etc., serve to anchor the new material. The new lining is made to a concentricity gauge, and as the ramming proceeds, the furnace is slowly rotated until the original boundary partition is reached, when the plank is removed and the lining levelled. The lining is first air-dried for half a day and is then heated at 400 deg. C. for three hours, after which full heat is applied until the temperature has risen to 1,500 deg. C. Four hours later heating is stopped and the furnace is ready for use on the following day.

This method of effecting repairs realises a saving of 60 per cent. of rammed material since the latter is applied to the old lining. The furnace is only put out of action for 48 hours or three days at the most, instead of for a fortnight or three weeks with the vertical method of ramming which is still practised in some foundries.

When lining furnaces or the like of small size, such as converters of 1½ to 2 tons capacity, small rotary furnaces or electric furnaces of moderate size, templates are employed and ramming is carried out by means of compressed-air rammers.

Special Rammers Used

The work of ramming the material should be supervised. The tendency of the workmen is to ram too much material at a time, and night work, even when supervised, is always badly done. The material rammed at a time should not exceed about 1½ in. in thickness when rammed. A square beetle of very hard steel provided with diamond-shaped projections or studs like the hammers used by quarrymen is employed for ramming. The length of base of these projections or pointed studs is about ⅝ in. and their height is ¼ in. Small stampers are commonly employed for ramming refractory materials, but examination of the lining shows that the portions of material rammed at a time do not penetrate one another in that case. Ramming with beetles having diamond-shaped studs promotes the union of the various portions of rammed material.

Some furnacemen are accustomed to clean out their furnaces after casting, the object being to melt the oxides of iron and slag. This cleaning of the furnace takes place while the latter is still hot, since it has supported a temperature of 1,600, 1,650 or 1,700 deg. C. for three hours. The lining is softened and in places temperatures of 1,800 deg. C. are attained, causing the lining to run. This method is in favour in numerous foundries and results from the old custom of cleaning the cupolas at the end of the melting operation by allowing the charge to descend very low and then adding a considerable quantity of coke. The walls of the cupola are well cleaned and are seriously attacked, but since the cupola is very easy to repair by means of refractory mortars or rammed materials of medium or low grade, or even ordinary foundry sand, the cost of the lining is not a matter of great moment in the cost price. This method of cleaning the furnace is prejudicial, both to the furnacemen and to the manufacturers of the lining material who has given a guarantee for the latter.

Starting Up Furnaces

When starting up a furnace having a new lining of rammed refractory material, it is found that the lining is seriously attacked in the first operation. This may be easily explained and should not give rise to anxiety. Before vitrification to any considerable depth occurs, it is produced first of all to a depth of a few tenths of an inch. Since the mechanical strength due to the cohesion of the clay disappears, disintegration takes place, but only when the lining

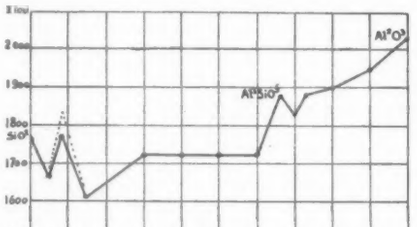


FIG. 2.—SHOWING THE EFFECT OF SILICA AND ALUMINA CONTENTS ON THE MELTING POINT OF REFRACTORY MATERIALS.

begins to "sweat." The unfused silica grains follow the flow of the clay. This deterioration may be obviated by suddenly raising the temperature when vitrification will then take place to a considerable depth and the lining will be protected.

In some cases rapid vitrification of the furnace lining may be brought about by introducing bottle glass in the proportion of 3.5 lbs. per square yard of lining surface. The furnace lining may likewise be vitrified by introducing a few pounds of ferro-silicon, ferro-manganese or spiegeleisen. A patented method which the author has used for some time is to paint the interior of the lining with aluminium powder made into a paste with sodium silicate. An aluminium silicate, theoretically capable of withstanding a temperature of 1,900 deg. C., is formed on the surface.

As stated above, the materials employed for the construction of rammed furnace linings contain 6 to 8 per cent. of alumina. Materials employed for repairs may contain 9 to 10 per cent. of alumina. There is never any advantage in exceeding 12 per cent. of alumina, and from melting point tests on the binary mixture of silica and alumina, it has been found that 14.5 to 14.8 per cent. of alumina gives the lowest refractoriness of this mixture.

Refractoriness

Siliceous materials for ramming contain 92 to 94 per cent. of silica, have a melting point of 1,770 deg. C. and their softening point lies very near to their melting point. It has been found that, starting from 100 per cent. of silica, a mixture of silica and alumina suffers a drop in refractoriness up to 6 per cent. of alumina but afterwards, up to 9.2 per cent. of alumina, there is a rise in the melting point from 1,790 deg. C. to 1,810 deg. C. The melting point curve then shows a very low minimum (1,585 deg. C.) for the mixture of 85.5 per cent. of SiO_2 and 14.5 per cent. of Al_2O_3, to rise again in favour of sillimanite and more aluminous products. This is shown in Fig. 2.

Use of Refractory Ramming Materials

Refractory ramming materials are employed for: (1) The construction and repair of iron and steel melting furnaces and metal-working furnaces; (2) the lining of ladles, and (3) stove setting. The use of rammed materials is justified in rotary coal-fired or oil-fired furnaces (Stein, Carbonatum, Brackelsberg, Sesci) for melting cast iron and steel. Some of these furnaces which have been built for some time in England have a capacity of 15 or even 20 tons of steel.* The diameter of the furnace is 10 feet and the overall length is 30 feet. The durability of the rammed material in this type of furnace is much greater than in furnaces of smaller size, some 10 ton furnaces being capable of giving 300 melts.

In principle, it is impossible with rammed linings of acid material to carry out treatments of a basic nature in the electric furnace during the melting operation, for instance desulphurisation of cast iron or steel by the addition of carbonate of lime. In consequence of the movement of the molten metal and the contact of the electrodes with the metal bath, the carbonate of lime attacks the walls of the acid lining with the formation of silicate of lime melting at 950 deg. C. The author has eliminated this trouble by incorporating siliceous sand with the limestone. The electrodes are raised, the desulphurising agent is introduced and rapidly vitrifies in the interior of the furnace, the slag remaining in a compact mass in the centre of the bath, where it can be removed very easily by means of a rabble.

The linings of induction furnaces for bronze and brass demand very close attention to the fineness. The index of fineness should not be less than 80, failing which the lining will become metallised. The lining materials for induction furnaces may be siliceous or silico-aluminous with 44 per cent. of alumina. Crushed burnt fireclay or broken saggers of good quality mixed with the clay provide materials of very good quality which have been used in France and England for 25 years.

Electric Furnace Uses

High-frequency steel furnaces require siliceous lining materials of very good quality because the furnace operates under very heavy conditions, the temperature in some instances rising to 1,700 deg. C. in under two hours. The roofs of Héroult electric furnaces are now being made of rammed refractory material of low alumina content (2 per cent.). The very high coefficient of expansion of this material makes it possible to produce a roof in a single block, the life of which far exceeds that of the best quartzite brick roofs. Bessemer converters and all melting plant in general are also lined with siliceous material containing 8 to 10 per cent. of alumina.

Steel plant ladles of up to 80 tons capacity are also lined with rammed siliceous material. Since such a lining is not so thick as one of bricks, the capacity of the ladles is thus increased and the cost price is lower than that of brick-lined ladles. For some time, the author has been making the linings of central heating boiler furnaces of rammed material and the application of these materials to stove-setting does not give rise to any difficulties. If care is taken to secure constant volume and to have a material suitable for the installations enumerated,

* Iron.—Editor.

rammed linings have a longer life and imply a considerable saving as compared with brick linings.

Basic or neutral ramming materials are also manufactured for making the sides and bottoms of Héroult furnaces. Magnesia is employed, with tar as binding agent. The crushed magnesia is heated to 150 deg. C. on a piece of sheet iron for the sole purpose of removing the moisture so that the tar will not congeal on the surface of the grains. The tar is also heated to 200 deg. C. in a suitable container. The magnesia having been dehydrated at 150 deg. C. is sprayed with the liquid tar and is mixed with a spade, the furnace lining being rammed at once before the material cools.

This method of mixing with tar is not always satisfactory. During the first melting operation, it sometimes happens that the tar melts instead of carbonising because the temperature at the back of the lining is not sufficiently high, and in this case the lining slips in the interior of the furnace. The tar may be replaced by a ramming material of magnesia and clay. The magnesia has the same degree of fineness as before, but clays containing 38 to 40 per cent. of alumina of very good quality and having high binding properties are employed. The magnesia is mixed with 7 to 10 per cent. of dried and crushed clay which is moistened with water, and when the mixture is homogenous and has a moisture content similar to that of normal ramming material, the lining is rammed. The calcined magnesia employed for making this material should have the following chemical composition: MgO, 87; SiO_2, 6; Fe_2O_3, TiO_2, 4 to 7, and loss on ignition, 0.2 per cent.

The specific gravity of the material should be 3.5 and the porosity 10 per cent. Its refractoriness should be higher than Saeger 39. Its change in volume after heating for two hours at a temperature corresponding to Saeger No. 30 is 1 per cent. The softening temperature under a load of 2 kilograms (about 28.5 lbs. per sq. in.) is 1,300 deg. C. and its crushing temperature under the same load is 1,425 deg. C.

Products made from magnesia are somewhat expensive, and therefore furnace linings are made from dolomite, a double carbonate of lime and magnesia. The following is the composition of a good calcined dolomite for ramming materials: CaO, 58; MgO, 30; SiO_2, 5; Fe_2O_3, 3, and loss on ignition, 4 per cent.

Dolomite may be agglomerated with tar or with clay in exactly the same way as magnesia.

Catalogue Received

Sand-Testing Equipment. No broadminded person would object to our labelling Mr. Harry W. Dietert as the world's leading authority in sand-testing apparatus, as his firm, located at 676, West Grand Boulevard, Detroit, Michigan, manufactures the standard apparatus sanctioned by the American Foundrymen's Association. A catalogue received from his company is not merely interesting—it is definitely useful—as, for instance, a table inset at the end details methods of overcoming common defects due to sand troubles. Obviously such a catalogue requires intelligent application, as not all the various types of A.F.A. apparatus are standardised on this side of the Atlantic, and modifications, here and there, have been introduced, whilst in other cases, the "cat is killed" by entirely different methods. For instance, the Americans have not yet availed themselves of a machine of the "Speedy" type for moisture determination, their method being based on the passage of electrically heated air over the sample of sand. It is called the "Moisture Teller." This catalogue ought to be in the hands of all foundries possessing a sand-testing laboratory and especially members of committees dealing with this subject.

West Yorkshire Foundrymen Discuss Tolerances

A meeting of the West Riding of Yorkshire Branch of the Institute of British Foundrymen, in Bradford recently, discussed the Institute's Technical Sub-Committee's report on "Dimensional Tolerance of Castings, with Particular Reference to Malleable Cast Iron." In the absence of the Branch-President (Mr. Joseph Hepworth, M.P.) on Parliamentary duties, the chair was occupied by Mr. H. Forrest (Senior Vice-President).

MR. F. K. NEATH, B.Sc. (Immediate Past Branch-President), outlined the Report*

MR. W. G. THORNTON (Past-Branch-President) said there was no doubt that the Sub-Committee had gone to much trouble in accumulating and tabulating all this information. Speaking as one interested in cast iron, Mr. Thornton said one had to realise that although that side of the industry had vastly different classes of irons to deal with, it was equally entitled to consider tolerances as were members of the malleable section. In some cases there was no contraction at all, but they had a very big range of irons to consider. As one who was interested in repetition work he felt the allowances given by the Committee were quite lenient.

MR. J. SMITH asked whether the rail-chair castings mentioned in the Report had been cast at the same temperature. Control of casting temperature would make a difference.

MR. NEATH said the meeting could only consider them on the assumption that they were representative of a day's work and would cover any variations in temperature.

Domestic or Supplied Patterns

MR. T. J. L. SLINGSBY said in discussing this matter a very important factor was whether the work was supposed to be based on patterns supplied by the customer or made by the foundry itself. If supplied by the customer, he suggested that the foundryman should take no responsibility whatever in regard to variation of contraction. The foundry, in Mr. Slingsby's opinion, should not accept any specification to be bound within limits in making castings from a customer's specification.

MR. NEATH said though he believed this was the general opinion of the Sub-Committee, he would gladly emphasise that point to the Sub-Committee.

The CHAIRMAN thought that for a man making a casting 8 ft. long, a ½-in. tolerance was too fine a limit to work to.

MR. SLINGSBY said that when dealing with an inspector much depended on whether he was considering strength and weight or defects in the sand face. With a smaller casting a smaller limit suggests itself, but not so with a large casting.

MR. A. S. WORCESTER (Past-Branch-President) said he gathered that the fundamental notion of bringing forward this Report had been to correlate tolerances. It may be a sales department aspect, but it seemed to throw the onus on the industry generally. In ordinary grey iron they have many factors to cause trouble. Neither the limit of camber nor the amount of machine allowance had been mentioned. Another bugbear with all foundrymen was the jigging or location points. The foundryman ought to be able to decide with the engineer where these location points were to be situated. The kernel of this problem, from the malleable point of view, was that such foundries were often supplied with customers' patterns and they were expected to produce accurate castings from them.

Continental Tolerances

MR. SLINGSBY thought the tolerances specified for over 8 in. were much narrower than the tolerances specified by some Continental authorities. He promised to send to Mr. Neath some details of some German work for submission to the Sub-Committee, and he felt that malleable founders should reject the customers' patterns in regard to tolerances. If the Sub-Committee had time and money available, he thought it might do well to make more experiments.

MR. WORCESTER suggested that Mr. Slingsby, as a malleable iron founder, should be put into personal touch with the Sub-Committee.

MR. J. SMITH said that, as a patternmaker, if one had to work to close limits, one ought to make one's own patterns in the foundry.

MR. FORREST said it must be recognised that in some cases—in the motor car industry, for instance—they had to work to very fine limits. They had cast crank shafts and motor cylinders with great accuracy. Pistons were cast by weight; the tolerances in many cases were much finer than in the general jobbing foundry. The Sub-Committee represented all these various kinds of work, and these specifications which it was attempting to make would, in his opinion, refer more especially to the engineering shop rather than the general jobbing foundry.

Vote of Thanks

On the motion of MR. FORREST, seconded by MR. S. CARTER, hearty thanks were expressed to Mr. Neath for his able *résumé* of the Sub-Committee's Report and his comments thereon.

MR. NEATH, replying, reminded the members that this was their own Institute's work for the good of the members. If any of them could help in any particular point from their own experience or special knowledge, they should not hesitate to get into touch with the Sub-Committee.

* FOUNDRY TRADE JOURNAL, August 6, 1936, p. 99, and August 13, 1936, p. 125.

Publication Received

Codes for Exhaust Systems and Testing and Measuring Air Flow. The American Foundrymen's Association has recently approved and published two Tentative Codes of Recommended Practices developed by its Industrial Hygiene Codes Committee. These codes are the first two in a series of some 25 codes being developed to assist in the standardisation of dust eliminating methods and improvement of shop operating conditions in the foundry industry. The two codes which are now available are:—36-27—Tentative Code of Recommended Practices for Testing and Measuring Air Flow in Exhaust Systems, and 36-28—Tentative Code of Recommended Practices for Grinding, Polishing and Buffing Equipment Sanitation.

Code 36-27 is prepared to aid in the standardisation of the general type of instruments and technique employed in determining the volume and velocity of air flow in exhaust systems. It covers the application and testing technique for Pitot tubes, inclined and vertical manometer gauges, revolving vane type anemometers and swinging vane type direct reading velocity meters. The thirteen figures contained in this code add greatly to the methods described.

Code 36-28 describes recommended practices for the ventilation of all grinding, polishing, buffing, scratch brushing or abrasive cutting-off wheels, and grinding or polishing straps or belts and is very similar to the new State of Illinois Buffing and Polishing Equipment Sanitation Law, which many of the A.F.A. Industrial Hygiene Codes Committee members helped to draft. A series of definitions is followed by sections on applications for hood and branch pipe requirements, design of exhaust systems, testing exhaust systems and hood and enclosure design and minimum air velocity required. The numerous illustrations will be found very helpful in aiding plant engineers in designing effective equipment to meet plant requirements, especially for the smaller foundries.

Copies of these codes may be secured from the American Foundrymen's Association, 222, West Adams Street, Chicago, Illinois, at the price of 2.00 dollars a copy.

East Midlands Foundrymen Discuss Patterns

After MR. S. A. HORTON had presented his Paper on "Patterns and their Relation to Moulding Problems"* to the East Midlands Branch of the Institute of British Foundrymen, an interesting discussion took place. We append a report.

MR. P. A. RUSSELL, opening the discussion, referred to the use of aluminium patterns, and asked whether difficulty through pitting had been experienced. He had found them satisfactory when new, but when they were taken from the store, say, about three years later, they were usually in a bad condition, due to this defect. Regarding the balancing of cores and the suggestion that the core-prints be equal in length, he asked if that length was sufficient. He always thought a print was required which was longer than the core projected into the mould. He suggested that the patternmaker should paint a line along the joint on the pattern, for the guidance of the moulder, and, referring to taper, his experience was that one could persuade a patternmaker to deal correctly with patterns but not with core-boxes. He instanced a cube pattern that was made to taper from 12 in. to 11¾ in. for the purposes of moulding. The core was made to withdraw from the box in an opposite direction, and the taper on the core, being in the opposite sense, did not give the correct wall thicknesses. They had the utmost difficulty in persuading the patternmaker to maintain the size, by making the core-box with loose sides so that the taper was constant. Finally, Mr. Russell referred to top core-prints. With a core that was placed in the bottom and projected in the top half of the mould, the patternmaker could assist if he made the top core-print oversize.

MR. HORTON said the aluminium patterns he referred to were never in the stores. The trouble he experienced was preventing the moulder from damaging the patterns with the vent wire. He usually used shellac for varnishing. He agreed that it would be a very great help if the patternmakers marked the mould joint, but they usually had insufficient time.

As to core-print taper, with quantity production it was essential that the core and core-print should be similarly tapered, whilst to minimise core-print crushing, he thought it was a good point to have the core-print in the top box slightly larger.

Core-Drying Distortions

MR. T. GOODWIN, referring to the differences in contraction between the oil-sand core and the green-sand core, asked if the variation was due to the rate of cooling. He thought it would be advisable, with the box casting with the balancing print, to have made a casting on each end of the core, thus making it self-balancing.

MR. HORTON replied that he had only given the contraction figures to show the variation. He was not prepared to say whether it was due to the cooling effect of the core. Unless the patternshop allowed for the contraction there was bound to be some difficulty. Regarding cores balancing on a print, he said it was good practice, if the foundry could afford it, to have two patterns made.

Unused Rapping Plates

MR. J. LUCAS said he was responsible for many patterns used in many different foundries. A large number of patternmakers had never seen the inside of a foundry, and one had to contend with that factor nowadays. No two foundries used similar methods, and where one foundry would agree that a pattern was satisfactory, another foundry would condemn the same pattern. Patternmakers were reproached because they did not put rapping plates in the correct position; but patterns which had been returned to him showed clearly that the rapping plates had never been used. As to contraction allowances, he had sent patterns to one foundry, and the resulting castings were too large; yet the same patterns, when sent to another foundry, gave the opposite effect; but the patternmaker was blamed in both cases.

The lecturer had mentioned core drying, and Mr. Lucas asked if he had had any experience of a dried core being different in shape or size from the core-box. His own view was that in many cases a core, when drying, did sometimes change in size. A patternmaker could not be expected to make a pattern to suit every foundry. He thought that a jobbing foundry should say to each customer what it expected from the castings ordered and what sort of patterns they should supply.

MR. HORTON agreed with some of Mr. Lucas's remarks. The patternmaker should ask the foundry for suggestions how the pattern should be made, as every foundry carried out various alterations. He, personally, had usually found that variations in core sizes after baking were attributable to a faulty drier, which had allowed the core to take the shape of the drier.

Pitting of Aluminium Patterns

MR. J. F. DRIVER appealed for greater collaboration between various departments, and he suggested that there was too much working in water-tight compartments. His definition of a working drawing was "a method of representing an object," and if it was a perfect drawing, a skilled workman would then be able to make the object without any difficulty. A draughtsman had no idea how a job was to be cast, but if it was designed with that knowledge, it would be more helpful.

Pattern drawings should be such that the taper was not left to the whim of a moulder or patternmaker, but was shown on the drawing, and, of course, designed by someone who was an expert. One would then obtain uniformity. He asked whether aluminium was not too soft a material, and if an aluminium alloy was used.

MR. HORTON said he used an aluminium alloy and found it an advantage, as he had experienced a certain amount of pitting with the aluminium alone.

MR. C. B. HALLAM said a patternmaker was very often asked to make a pattern as cheaply as possible; therefore insufficient time was expended upon it, to the detriment of everybody.

MR. J. GERRARD said he was glad to hear Mr. Goodwin suggest that small castings should be made as two castings instead of one, to effect balance of core.

Unvarnished Patterns

MR. H. REEVE said the varnish on certain patterns he dealt with was a source of dissatisfaction. The number of patterns reaching the foundry unvarnished was remarkable. Often a pattern took perhaps an hour to mould, and by the time the pattern was stripped, the mould would crumble to dust, as the unvarnished wood had absorbed the moisture in the sand. Naturally, some firms required patterns to be made too cheaply and too quickly.

MR. R. H. BUCKLAND, speaking with regard to quoting for new jobs, said a customer would often prefer to supply the pattern, probably on account of cost. He thought in such cases it should be stated, when the price was quoted, that the pattern was to be made in a specified manner, and if possible a sketch should accompany the quotation.

MR. G. L. HARBACH thought there should be a move on the part of the Institute to insist that all engineering apprentices should have some experience in the foundry. A draughtsman should also go through every department of a works.

Lifting Straps

MR. H. BUNTING (Branch-President) said that one point not mentioned in the discussion was the removal of the pattern from the mould. With large patterns it was common to find no lifting straps on the pattern. One particular job he had in mind was about 3 ft. deep, 1 ft. square, and only ¼ in. thick, yet the pattern was provided without straps. Naturally it was very difficult to strip such a pattern from the mould. Another important point, especially in the larger type of work, was the small core print, for a core entering into the side of the mould usually had only from 1 to 2 in. of print. It was ridiculous to deliver such a pattern. A moulder would have to cut away a large amount of sand to insert the core and to make it a workable proposition. He failed to understand Mr. Lucas's remarks on rapping plates. It might be that with the pattern in one foundry the rapping plates were easily accessible, but in another they might be covered by the box bars. These were points that the patternmaker should attend to when discussing with the foundry foreman how a job was to be made.

Vote of Thanks

MR. C. W. BIGG (Vice-President of the Institute), proposing the vote of thanks, said there were many points in the Paper that should be considered very carefully by them, not only as foundrymen but as members of the Institute. The part which appealed to him first was the necessity of co-operation between the patternmaker and the foundryman. Mr. Horton had said that a new standard was being set for castings, and that was what he tried to emphasise with regard to all patterns. Heavier demands were being made on the foundrymen on the whole, and it followed that all departments in the foundry should make a larger contribution to the result. Another speaker had remarked that many patternmakers had never been inside a foundry, but this state of affairs was altogether wrong. A patternmaker, to be efficient, could not produce a pattern unless he understood the difficulties under which that pattern was to be used. Many patternmakers did not understand the first essentials of sand manipulation, and he advised all the young patternmakers to learn the fundamentals, and give the moulder a finished article.

MR. R. SPRIGGS seconded the vote of thanks. The question of co-operation between the drawing office, patternshop and foundry, was very difficult, he said, and the larger a firm grew the more difficult this question became. They did co-operate more than they used to, but they still had a long way to go.

* FOUNDRY TRADE JOURNAL, December 31, 1936, p. 504, and January 7, 1937, p. 8.

Standard Bend Test on Welded Joints

The British Standards Institution have recently issued a specification outlining standard methods of making a bend test on welded joints. Whilst bending had from early days been regarded as a suitable form of test to which welds should be submitted, little information was available as to the interpretation to be placed on the result obtained or to indicate what should be regarded as the criterion of the test. As the specification points out different physical properties may be possessed by the weld metal and by the parent metal in any one joint, and consequently the factors which influence the test need to be carefully controlled and their relative values correctly assessed. The principal points to be observed are set out very clearly in the specification. Copies of the specification (B.S.S. No. 709—1936) may be obtained from Publications Department, British Standards Institution, 28, Victoria Street, London, S.W.1. (Price 2s. 2d., post free.)

Developments in the Production of Ingot-Mould Castings

By ROBERT BALLANTINE

(*Continued from page 5.*)

Moulding Boxes

The question of satisfactory moulding boxes is most important, and considerable experiments in design have been carried out. The mid-parts are made up of four separate plate castings with all joints machined. The perpendicular flanges are angled to 45 deg. Three of the corners are bolted, and the fourth is held by cotter bolts. This method releases strains and facilitates removal of the casting. A machined stripping plate is fixed to the underside of mid-parts, and is in two parts, split at alternate corners. This ensures carrying of the mid-part sand, and has the advantage of being easily replaced in case of alteration to design.

Copes and drags are of a semi-permanent nature and carry provisions for clamping, gating and flow'ers, the facing medium being loam. Joint faces in both cases are machined. Objectionable features, such as loam stamping, which softens the mould face near the drag, are eliminated, and the ever-present danger of run outs is counteracted. Moreover, fins which have a habit of solidifying rapidly, and causing endless trouble, are non-existent when machined boxes are in use. In the quest for further developments it was borne in mind that cast-iron boxes had their disadvantages, first in being easily broken unless of very heavy section, and secondly because the extra weight retarded jolting capacity. A fabricated steel box was evolved and introduced which allowed a 20-ton casting to be jolted successfully.

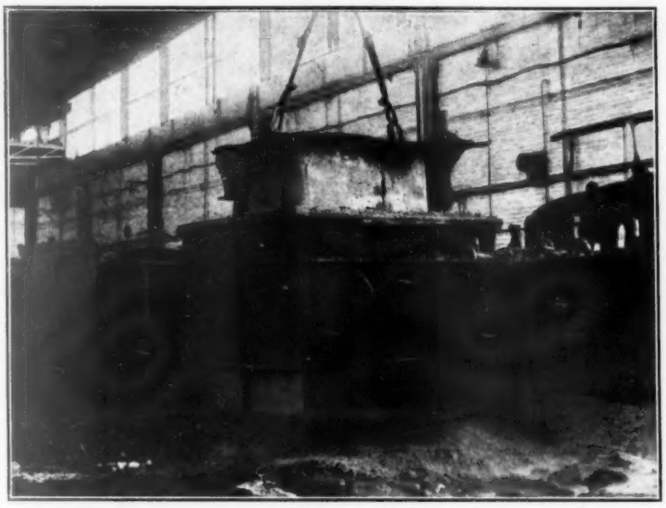


FIG. 9.—SHOWS A 16-TON CASTING BEING REMOVED FROM THE MOULD.

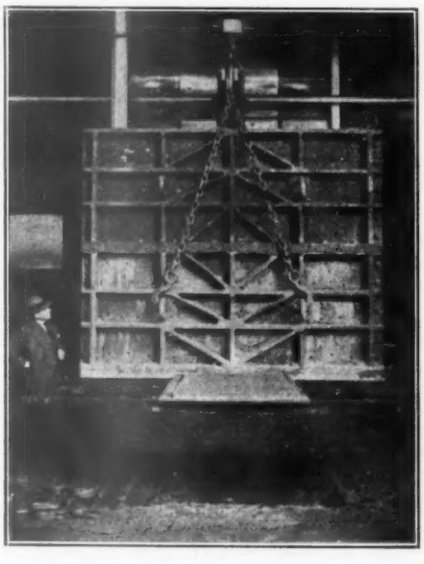


FIG. 10.—SHOWS TYPE OF MOULDING BOX USED.

FIG. 11.—MID-PART AND CORE FOR A 34-TON INVERTED MOULD ENTERING STOVE.

Fig. 9 clearly indicates the box under actual working conditions, with a 16-ton casting being removed. The box is a surface-table built job and is not elaborately reinforced. It is all-welded with riveted fixed corner angles. The casting is being removed after 60 hrs., and the absence of sand is most noticeable. Cotter bolts have been removed from the flange at the left-hand corner, and it is interesting to record that an opening averaging 5 in. occurs, making the removal of the casting a simple operation. There is rather a reciprocal peculiarity about this box, for the foundry supplies castings for the making of steel, and the steelmakers in turn supply steel plates for making the boxes in which some of these castings are made.

Fig. 10 illustrates a newly designed cast-iron box for making all types of large mould castings. When the copes and drags are included the weight is 22 tons in cast iron only. It will be observed that cross membering of stiffening ribs is introduced. The length of the box in this instance prohibited the machining of upright angle flanges, but the standard practice of all machined joints is evident.

Fig. 11 shows the mid-part and core for the 34-ton inverted mould casting being placed on stove carriage.

Mid-Part Jolting

The larger moulds are jolted on a 32 in. machine at 100 lbs. pressure. When the pattern is set in the mid-part, a layer of sand covers the stripping plate. Downgates are inserted, and at regular intervals sand and rod stiffeners are added in a similar manner to the core-making methods. The number of downgates is determined from actual practice, and ranges from one in the smaller moulds to four in the larger. Immediately after removal of the pattern the mid-parts are transferred to the finishing benches for ingate cutting and blackwashing, prior to entering the stoves. The number of ingates inserted, like the downgates, is determined from results obtained in practice.

Fig. 12 shows the mid-part for the 30-ton (ordinary) type ready for removal to the drying stoves. The four downgates are shown, and also the loam gutter recess for stopping the flow of metal at the cope parting.

FIG. 12.—MID-PART FOR 30-TON TYPE READY FOR DRYING.

Closing and Casting

The assembly of cores and moulds prior to casting is a specialised job allocated to experienced employees. The closing movements are carried out in sequence, so that casting operations follow, allowing a reasonable margin of

safety for the closing squad. The proper skimming of ladles has long been practised, and is an essential operation. The question of teapot and bottom-pouring ladles has been considered, but the present system has much to commend it for adjusting the rate of flow, in keeping up heads and in easy sculling and fettling of the ladle.

Gating, Risers and Feeding

All ingot-mould castings are run by downgates and the ingates are formed in the mid-parts. Top pouring by pencil gates has been discarded in favour of the former system. Opinions are divided as to the best methods of running any casting, but the author's experience is that for this type of work made in dry sand the results show much cleaner tops and internal surfaces than by the drop-gate method. Whether or not to feed a casting is a question

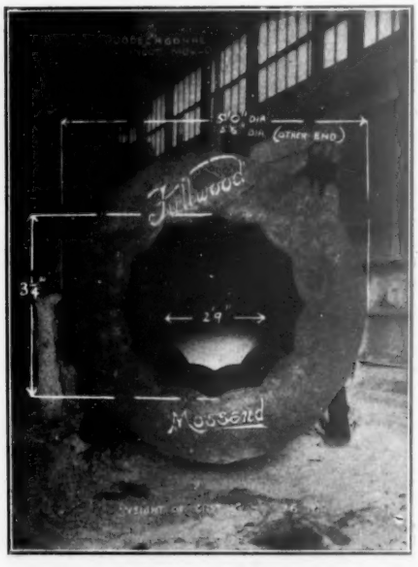


FIG. 15.—END VIEW OF A 26-TON CASTING, THE CORE FOR WHICH WAS SHOWN IN FIG. 5.

which evokes a great deal of controversy, but it has never been found necessary to feed these castings either by feeder rod or feeding head. At the same time, one is justified in asking where the 4 cwts. or more of metal used in feeding goes. But is not there something advantageous in its absence?

The metal thicknesses in ingot-mould castings are reasonably uniform, and it would appear the necessity for feeding does not arise. An examination of fractured mould castings reveals an open metal structure in place of a denser structure in the wall centre. When expansion of the mould takes place in service, it is very probable that the initial shock of rapid change in temperature is counteracted by a resilient or cushioning effect resulting from this phenomenon. This effect possibly tends to hasten the crazing of internal surfaces, but, at the same time, it lessens the possibility of discards by major cracking and consequent losses through split ingot moulds in service.

Patterns and Coreboxes

The production of ingot-mould castings in sand necessitates special care in the making of patterns and core-boxes, especially when operations are on a mass-production basis. Substantial bridging, internal cross membering, and cleating in pattern construction are essential if successful jolting is to be accomplished. Even more exacting service is demanded from the corebox due to the alternate corner splitting, which is so essential to easy removal of the core.

Fig. 13 illustrates a 20-ton ordinary-type pattern and corebox, with an 8-ton octagonal inverted pattern on the ground level. The 20-ton pattern is plain but massive, and the corebox is reinforced with 5 sets of 4-in. by 3-in. by ½-in. angles fixed on 11-in. by 3-in. cross beams. Upright stiffeners are inserted to counteract the jolting shock. Special care in finishing both patterns and coreboxes is the rule. Three coats of special varnish paint are given. The benefits of this procedure can be assessed by clean pattern withdrawal and cores which do not require patching. All patterns are painted in orange colour so that the contrast when pneumatic ramming takes place is dominant.

The coarse nature of the sand used has a high abrasive action on the varnish paint, but periodical repainting maintains the good drawing qualities. The contrast is most marked when the pattern and corebox of an older type of mould, which is not painted, are compared. As manufacturing by the loam method is not practised, it is advisable at times to use makeshift methods for a one-off job, and in the following is an example.

A large type of octagonal mould is shown in Fig. 14. An existing pattern was used and a series of three movable sides added. Ramming operations were started on the three eke parts which, in turn, were withdrawn from the sand and replaced at other parts. The corebox was constructed on a one-off basis, but was rammed by pneumatic rammers, being unsuitable for jolting.

Iron patterns and coreboxes are extensively used, and one is assured of a true-to-shape casting resulting from their use. There are two objections to them however: they do not lend themselves to easy alterations, and the sweating effect on the surface, when they are in daily use, has a tendency to "start" the sand if excessive rapping takes place. On the other hand, patterns and coreboxes made in wood, and suitably reinforced, give a fine job, are easier to alter and rarely adhere to the sand. Their upkeep, however, is costly as they require constant inspection and adjustment.

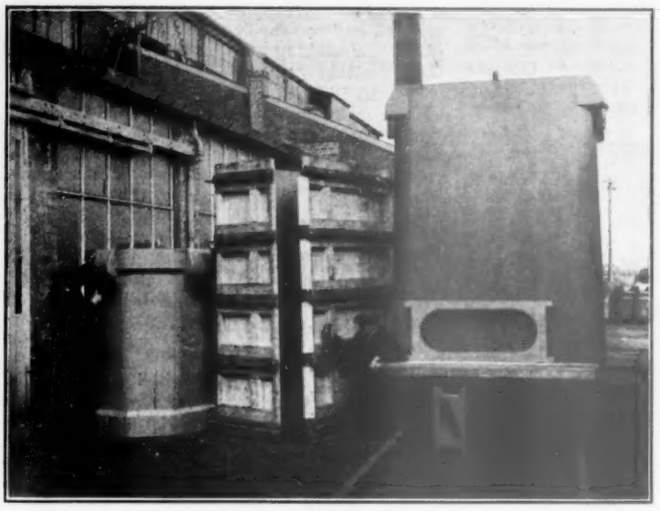


FIG. 13.—PATTERN AND COREBOX FOR 20-TON INGOT MOULD.

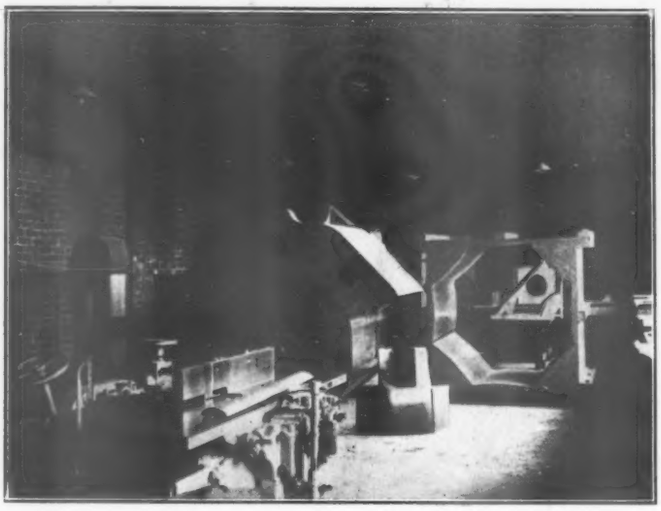


FIG. 14.—PATTERN FOR A LARGE OCTAGONAL MOULD.

Analysis, Manufacture and Usage

So much has been written about analysis for the ideal ingot mould, that it is with a certain amount of hesitancy that this subject is introduced. Careful scrutiny of the various investigators' findings leaves the author looking for some definite indication of analysis. Equally good lives have been obtained from ingot-mould castings with fairly wide variance in composition.

FIG. 16.—SHOWS THE CASTING SHOWN IN FIG. 15 IN VERTICAL POSITION.

Dr. T. Swinden and G. R. Bolsover give: T.C, 3.5 to 3.75; C.C., 0.3 to 0.6; Si, 1.9 to 2.3; Mn, 0.6 to 1.0; S, 0.03 to 0.05, and P, 0.03 to 0.045 per cent. They state in addition there is a tendency to limit the silicon to 1.7 or 1.9 per cent. with a higher manganese content of 0.9 to 1.1 per cent.

Other investigators, including Legrand, Shiokawa, Kruska, Leonard, Shaw and Blakiston, confirm the view that fairly wide variances are permissible, and this coincides with the author's view. Silicon at 1.8 per cent. and manganese not exceeding 0.9 per cent., with minimum sulphur and phosphorus, give good results. Blakiston in a Paper he presented to the Middlesbrough Branch of the Institute, advocated the need for research on the actual manufacturing side. He also suggested that, as an initial step, the internal core barrel should be eliminated. The author fully agrees with this statement regarding rigid core barrels.

Two objectionable features still have to be considered, for if the barrels are left in the cores strains are set up in the casting when cooling; alternatively, if they be removed the red-hot ingot-mould castings must be handled roughly to remove the internal barrel. On the other hand, a sand and ash centre core with a minimum of iron reinforcements allows for easy contraction of the casting. Compression of the core takes place, but as a unit. The ash centre relieves the sand compression when contraction takes place. It is felt that the method of manufacture coupled to subsequent use in the steelworks has a greater bearing on the lives of ingot moulds than that of analyses. In addition, the salvage value to the steelworks of discarded ingot-mould castings must be considered.

Design of Moulds, Weight Ratios and Lives

No attempt will be made in this practical Paper to summarise design, weight ratios and lives. There is such diversity of opinion in the various steelworks, all ably backed by actual experience, that definite standards in design are difficult to obtain. A mould design may be most satisfactory from a foundry point of view, but out of the question for producing a satisfactory rolling ingot. Again, there is experience of certain ingot-mould castings with objectionable features in design, as affecting the foundry, which give first-class rolling ingots and splendid lives.

Castings are supplied in accordance with the designer's conception of what is necessary to meet their service; but the tendency is towards weight reduction, as in general engineering castings. A comparison of weight ratios makes for interesting commentary. Ratios from 0.8 of the ingot weight to 1.5 are quite common. It is questionable if a stipulated ratio can be worked to, giving the best results unless local conditions of usage are studied.

W. J. Reagan has given results* of experiments on small octagonal moulds with a ratio as high as 2.5 of the ingot weight. A study of the graph given by Reagan reveals superior lives at this high ratio, with a maximum 250 casts. In personal records interesting comparison can be made. Standard 21 by 20 in. open-ended common moulds give average lives of 160 casts, with individual lives as high as 230.

Another example of the variation of life of ingot moulds can be cited. Ingot mould castings, weighing approximately 8 tons, for producing standard slabs, were sent to two steelworks. The design was standardised, the analyses within limits were similar, and the castings were taken from common stock. In the case of works A, there was an average life of 55 heats, and an individual life of 62—a very consistent record. On the other hand, works B obtained an average of 110 heats, with individual lives as high as 176 from similar castings. In this instance the foundry cannot be questioned, and in fairness neither can the designer nor the metallurgist. One must look for something appertaining to local conditions in the steelworks to provide a solution.

Good ingot-mould lives can be obtained by a combination of three vital factors:—(1) In the foundry, by having good coremaking practice, and by paying attention to apparently trivial safeguards. (2) In the design, by having a safety margin in wall thickness. (3) In the steelworks, by having reasonable attention and usage.

The lives of ingot-mould castings have increased very rapidly in recent years. At works B, for example, within the last 10 years these same 8-ton ingot moulds have risen from average lives of 43. Better metal, better treatment in steelworks, modified designs, co-operation, and improved foundry technique all add their quota towards better lives from these castings.

Metals and Melting

Hematite irons are exclusively used in manufacture. Discarded moulds are rarely used; only shop returns, such as gates and risers, are added to the pig-iron charges.

Casts as high as 182 tons in one day and from one cupola have been made, and daily casts of from 150 to 160 tons are quite common. Three cupolas of the solid-bottom type are installed.

(*Concluded on page 32.*)

FIG. 17.—INDICATES THE CROSS SECTIONAL THICKNESS OF A 26-TON INGOT MOULD.

FIG. 18.—SHOWS A VIEW OF THE MAIN BAY OF THE FOUNDRY.

FIG. 19.—SHOWS A STOCK OF ABOUT 2,000 TONS OF INGOT MOULDS.

* "Iron Age," October 29, 1936.

Estimating for the Foundry*

By C. M. WIGHT

Estimating is the predetermining of the conditions connected with the production of work and is carried out principally for protection against accepting orders at a price which would not be a commercial proposition.

An estimate may be divided into two sections, one being simple arithmetic and the other a matter of judgment. In the former section are placed the primary factors, viz.:—The weight and value of material required and wages for each operation through which the work must pass. The latter division covers the secondary factors or those considerations which affect the result indirectly, such as:—The length of time that floor space or pit area is occupied compared with the value of the work; extra tackle required; the amount and position of machining relative to the position of casting where difficulty arises in clearing deposits from important machined faces while pouring, and risks of rejection due to awkward coring, trouble from uneven section, and failure to withstand specified tests.

Some foundries are more favourably placed for dealing with these factors, and it becomes obvious that no rules for price fixing can be made that would apply equally to all foundries, so that various methods of estimating have been adopted. The results produced by these systems are widely divergent and are to some extent, although not fully, responsible for the difference in quoted prices. The variations in prices are more noticeable in work that is not the general type handled by a foundry or district where prices have automatically become standardised.

Buyers of castings occasionally find the highest tender to be as much as double that of the lowest price offered, which is a source of wonder to both the prospective buyer and those who are also competing. If the reasons for the differences in prices be investigated it will invariably be found that all cases of extremely low prices are due to faulty judgment or errors in calculation, whilst those which are high may also be due to the same reasons, or it may be that owing to commitments for any particular class of work, a greater quantity cannot be produced without increasing the facilities for production and working overtime, which reflect in a higher selling value.

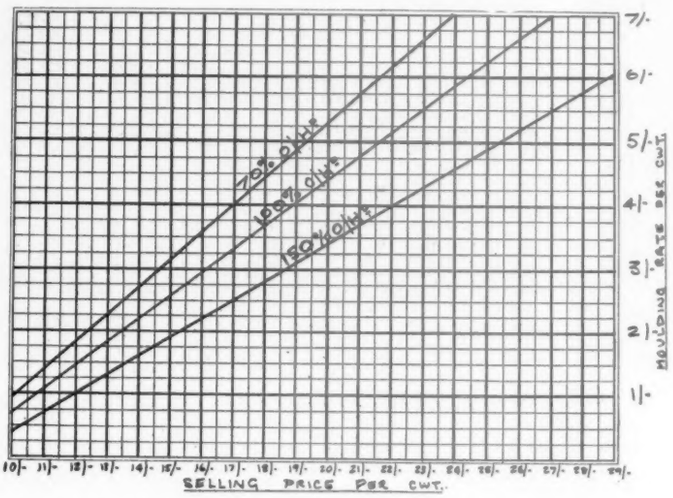


FIG. 1.—CHART SHOWING THE INFLUENCE OF OVERHEADS ON SELLING PRICE AT INCREASING WAGE RATES.

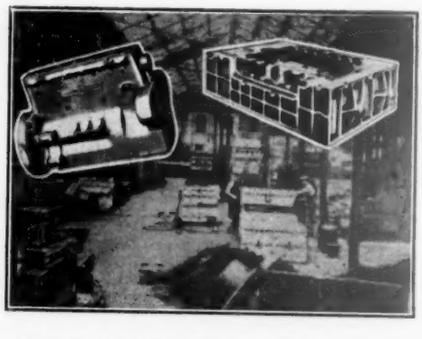


FIG. 2.—THE SIX CYLINDER BLOCK TAKEN AS AN EXAMPLE.

* A Paper read before the Newcastle Branch of the Institute of British Foundrymen.

Methods of Estimating Examined

An investigation of some of the methods applied to foundry estimating shows the following:—(*a*) An estimate is based on a cursory glance at the pattern or drawing, and a price is quoted according to what the estimator assumes the order for the castings will be placed at, or use is made of a previous selling price for similar work; (*b*) castings are classed by weight considerations only, and prices quoted in inverse proportion to the weight; (*c*) castings are classed according to type and weight; (*d*) estimates are based on previous orders for similar castings; (*e*) estimates are fully considered and prepared from the calculations of weights, and wages for each process in the course of production.

The first of these methods is guess-work and for obvious reasons should be discouraged. The second method is but little improvement on the first, as casting weights cannot in themselves be a guide to a selling price. The third and fourth methods are nearer to approximating a true selling price, but are complete only so far as similar work is concerned, and difficulty arises when no precedent is available.

In foundries where payment by result is on the basis of fixed rates per cwt. for various classes of castings, the system of quoting on type and weight is more fully justified, if considered with other conditions of manufacture.

When basing selling prices on previous records, changes in the method of production, rates of labour and cost of material must be taken into account. Old records should be used with caution, and a knowledge of the circumstances under which the work was previously executed is essential. The last method (*e*) is recommended for the reason that all points affecting the final price are considered.

Handling an Inquiry

On receipt of an inquiry, the specification is first examined for clauses that are difficult to meet, care being taken to see that no clause is so worded that the founder is liable for incidental or consequential damages in case of any failure of the casting when in working position, or for unavoidable suspension of delivery.

The next step is to examine the drawing, and if this is deemed suitable for manufacture, a check on the difficult points and a calculation of the weights are made. The method of moulding and the tackle required is also examined; then the mould and core wages can be determined. In the case of large jobs, these figures are probably best arrived at by dividing the job into sections and allocating so much per man per day. The wages for small work are on the basis of the number of castings made in a stipulated time. To the above wages must be added the dressing charges and war bonus.

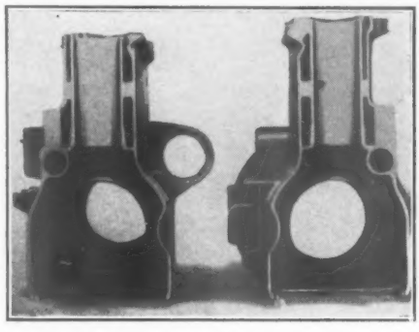


FIG. 3.—SECTIONS OF THE CASTING SHOWN IN FIG. 2.

Overhead Charges

The next factor is overhead charges. It is not in the scope of this Paper to recapitulate in detail the different methods by which overhead figures are obtained; perhaps it will suffice to point out that there are various methods, each equally good, of allocating overhead charges. For example, overheads may be based on tonnage output; on mould and core labour; on so much per hour for each operation; on a percentage on wages for each operation; on the total over the whole foundry, and, finally, so much on shop on-cost, taking all wages against production and adding a percentage for standing

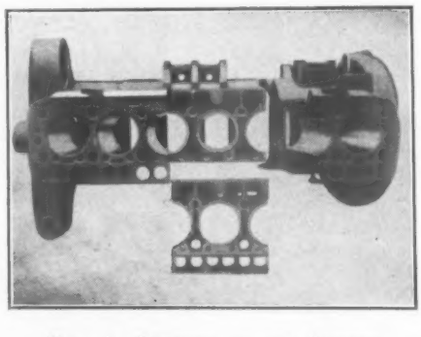


FIG. 4.—SECTIONS OF THE CASTING SHOWN IN FIG. 2.

charges, which covers rates and taxes, executive staff, office and sales expenses.

Any one of these methods may suit a particular foundry better than another, but the deciding factor is whether the overheads are absorbed or otherwise. Therefore, it is only possible to decide on figures from "costs" and experience of the actual working of the foundry in question. It must be assumed that the overhead figures have been compiled from an efficient costing system, and can be used with confidence by the estimator.

The estimator in turn has but little control in the manipulation of the overheads, as he does not decide the type of work for which inquiries are received. Only one thing is certain, that overheads can only be allocated to the work according to its type. For instance, ordinary plain firebars are sold at 7s. to 9s. per cwt. for the reason that this class of work need not carry more than 60 to 70 per cent. of the overhead costs, whilst jobs weighing 20 to 30 tons would require to carry 150 to 200 per cent. overhead, so that the estimator must decide on suitable overheads for each type of job and quote accordingly, keeping in mind the fact that small castings, such as firebars or brake blocks, do not need the handling or the use of cranes such as are required on large castings.

The price of metal can only be obtained from actual melting costs, which are influenced by such factors as the efficiency of the cupola or furnace in use; handling charges before melting; overheads, and the percentage of good castings delivered per ton of metal melted. The figure for this would probably be between 60 and 75 per cent.

Metal Costs

The method of obtaining metal costs is given as follows:—

	£ s. d.	
1 ton of metal charged at, say ..	3 15 0	
Cost of melting	0 15 0	
Making a total of	£4 10 0	
Allowing 5 per cent. loss, then weight of metal is 19 cwts., and the cost equals	4 15 0	per ton.
For each ton of metal melted assume 14 cwts. of good castings are delivered and 6 cwts. of scrap credited at, say, 3s.	0 18 0	
	£3 17 0	
which is equivalent to	£5 10 0	per ton.

Figures which appertain to one foundry are rarely of use or interest to others, as in both cases of overhead and metal costs, so many variations occur that each foundry must settle these questions in accordance with its own requirements.

Adjustments to accommodate variations in the cost of labour or material can easily be anticipated, once actual figures for overheads and melting have been proved.

A résumé of the foregoing remarks shows that the three principal items are as follow:—

		s.	d.	
Wages	mould ..	5	6	6s. 6d. = 3s. 3d. (2 cwt.)
	core ..	1	0	
	dressing ..	1	6	
	war bonus	2	0	
Overheads at 100 per cent.		10	0	
Metals at 5s. 6d. cwt.		11	0	
		31	0	

In the first column are placed wages, overheads, and metals; the wages in the second column have been sub-divided and values for overheads and metal have been allocated. In column 3, assumed values have been placed against each item, and the total value divided by the delivered weight, which in this case is 2 cwts. and gives a rate of 15s. 6d., to which must be added the carriage rate and profit. This is a typical example of the general type of estimate where no contingency or extra tackle are required.

It will be observed that the overhead cost figure covers all sundry labour, and the war bonus is based on piece work rates.

Attention is drawn to the figure of 3s. 3d. on the extreme right-hand side of the Table. This is obtained by dividing the mould and core wages by the weight in cwts, and is termed the moulding rate. This figure is to some extent a check on the estimated wages and can be used to facilitate further calculations as follows:—

Let it be assumed that the moulding rate is 1s. in one case and 5s. in another, and proceed to obtain equivalent selling values for each at 70, 100, and 150 per cent. overheads. This is set out in Table I.

Use of Standard Graph

In column 2 are shown wages and bonus, also dressing, which has been taken at an average of 15s. per ton piece price, and a normal profit of 10 per cent. is included. It is now an easy matter to plot these points and obtain curves from which any selling value can be determined, and Fig. 1 shows a set of curves determined from the previous figures; it will be seen that the figure of 3s. 3d. referred to previously is equivalent to a selling value of 17s. These curves can be extended to accommodate almost any selling price and apart from saving a separate calculation for each item the results are automatically checked. Further reference to the curves shows to what extent a difference in weight or wages affects the final price.

Let it be assumed that the estimated weight of a casting is 20 cwts. and the wages for mould and cores is £4 10s.; then the moulding rate is 4s. 6d. per cwt., which is equivalent to a selling value of 20s. 4d. per cwt. If it should happen that the actual cast weight was 18 cwts., the wages being as before, the moulding rate would then be equal to 5s. and the equivalent selling price would equal 21s. 8d., which absorbs 6½ per cent. of the estimated 10 per cent. profit.

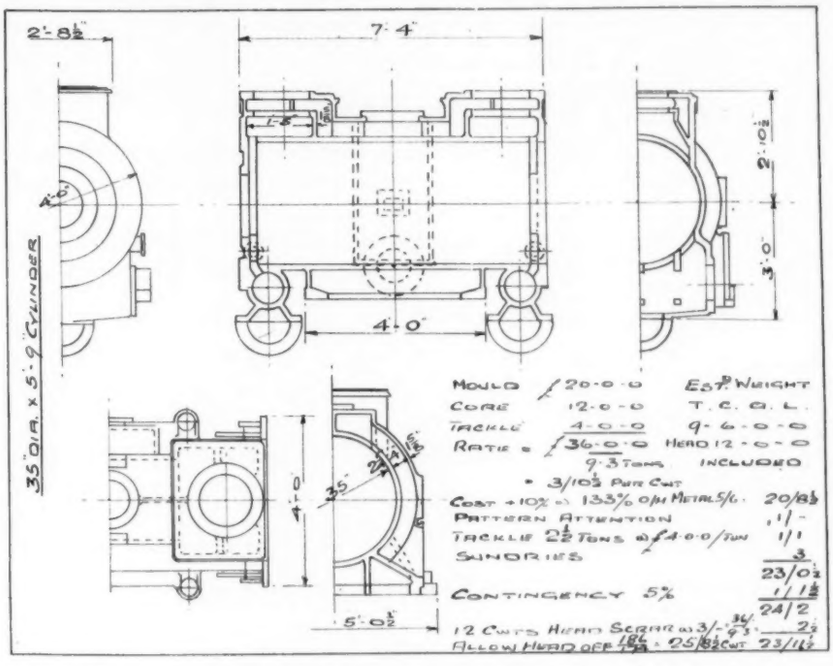


FIG. 5.—FILING RECORD OF TYPICAL BASIS CONDITIONS FOR ESTIMATING.

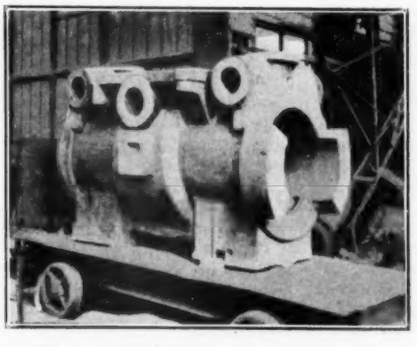


FIG. 6.—THE CASTING FOR WHICH AN ESTIMATE IS SHOWN IN FIG. 5.

TABLE I.—*Influence of Overheads on Estimated Selling Price.*

	Overhead, per cent.		
Mould and core	70	100	150
	s. d.	s. d.	s. d.
Wages, per cwt.	1 0	—	—
Dressing	0 9	—	—
War bonus	0 5	—	—
Total	2 2	2 2	2 2
Overhead	1 6	2 2	3 3
Metal	5 6	5 6	5 6
	9 2	9 10	10 11
Profit, 10 per cent. ..	0 11	1 0	1 1
SELLING PRICE ..	10 1	10 10	12 0
Mould and core	—	—	—
Wages, per cwt.	5 0	—	—
Dressing	0 9	—	—
War bonus	1 4	—	—
Total	7 1	7 1	7 1
Overhead	5 0	7 1	10 7
Metal	5 6	5 6	5 6
	17 7	19 8	23 2
Profit, 10 per cent. ..	1 9	2 0	2 4
SELLING PRICE ..	19 4	21 8	25 6

On the other hand, if the wages be underestimated and a price of £5 has to be paid, then the moulding rate is 5s., which is equivalent to a reduction in weight to 18 cwts. It is, therefore, obvious that close attention must be given to both weights and moulding wages. This es-

pecially applies to light work and low rates of labour where the increase of say 1d. on 9 lbs. is 1s. 0½d. per cwt., and would raise a selling price of 24s. to 26s. 9d. per cwt.

Apprentice Labour

When dealing with low rates of labour, such as boy or semi-skilled labour, the overhead charges should be adjusted, as it is apparent that a normal overhead rate charged on 1d. or 2d. per casting would not contribute much to the foundry expenses. To meet the case the overhead cost is increased *pro rata* to the wages saved. For instance, if a man's wages were £1 and overheads were £1, the total is £2. A boy's wages at 7s. would require first 100 per cent. on 7s., that is, a total of 14s. and 100 per cent. overhead on wages saved would equal 13s., making a total of £1 7s., against £2 at full rate.

In the case of estimates for castings which can be machine-moulded, the first considerations are the size of casting and number off. The first item decides the number which can be obtained per box, and the number required determines whether or not the amount of work in setting up will be repaid by the reduction in moulding wages.

No useful purpose will be served by endeavouring to define exactly the minimum number or type of casting that can be economically manufactured by machine-moulding processes, as each estimate must receive consideration in relation to the nature of the castings to be produced. Generally speaking, not less than three large castings, say of about 3 cwts. each, or ten of a smaller type, each sufficient to fill a 16 in. box, could be machine moulded economically.

The ideal condition for machine moulding is where several hundred castings are required, when the pattern costs per casting are negligible. The difference in wages should be in the ratio of one for machine moulding to between three to five for hand moulding. This apparent saving on prime cost of production must therefore be adjusted in the estimate to provide for upkeep, power and depreciation of the machine.

An example of machine moulding is given in Fig. 2. The casting is a motor six-cylinder block, and weighs 6¼ cwts. In this case the difference between machine- and hand-moulding wages is 12s. 6d. per casting, or a ratio of one to two machine to hand moulding. Perhaps a greater saving would have been expected, but the finishing, coring, and closing were fairly heavy items, which will be appreciated on examining Figs. 3 and 4. In the right top corner of Fig. 2 is a half mould, and below it is the machine lay-out; and on top left-hand side is the casting.

Estimating for Heavy Castings

For heavy work the method and basis of an estimate are the same as for light work, excepting for some additions. To illustrate these points fully, it is assumed that an inquiry has been received for a cylinder to a drawing such as is shown in Fig. 5, and to a specification which only called for normal tensile and hydraulic tests, and was clear of all binding clauses.

Examining the drawing, it is quite obvious that the cylinder should be moulded on end, and that a head or part head will be required to prevent a draw at the change of section under the top heavy flange and to carry away dross, etc.

The thickness of the cylinder body is 2½ in. finished and other scantlings as 1⅝ in., so that under these conditions the jacket cores should not present any difficulty, especially as there are ample venting facilities. It will next be seen that draw-backs will be required to form the two sides of the mould carrying the valve ports and at the front and back for the foot. This will involve a matter of 2½ tons of tackle in the form of binding plates, and it will be necessary to mould in a pit of 11 ft. 6 in. by 8 ft. 6 in. by 9 ft. 6 in. deep minimum size. The mould and core wages can now be ascertained and times allocated, as follow:—

	Hrs.
Preparing bed and setting boss	24
Ramming up to top joint	70
Finish draw-back joints	20
Draw-back left-hand side	68
„ „ right-hand side	30
„ „ head	18
Ram top	38
Finish ready for dryers	62
Close and cast	62
	392

This figure represents approximately the normal time in which the mould could be made, so that for the total of 392 hours at the standard rate of 48s., it gives the equivalent of £20 wages.

The price for the cores was made up in a similar manner and amounted to £12 (235 hrs.). The extra cost of special tackle was £4. This gives a total of £36 and a calculation of the weight gave 174 cwts. plus 12 cwts. of head. The moulding rate is £36 divided by 9.3 tons, which equals 3s. 10½d. per cwt., and represents a selling price of 20s. 8½d. per cwt., when carrying 133 per cent. overheads and using metal at 5s. 6d., which is calculated on the delivered weight of the casting.

A comparison of the weight of the job with the length of time that a pit should be occupied was in this case normal, and therefore does not affect the price.

To this price must be added allowances for the following:—(1) Tackle material; (2) pattern boards and attention of patternmaker during moulding and closing; (3) sundries, and (4) contingency.

The tackle is calculated at £4 per ton, which allows for scrap value on the metal returned and makes an addition of 1s. 1d. per cwt. Pattern charges are at 1s. per cwt., and sundries at 3d. per cwt.

The contingency allowance is, of course, purely an arbitrary factor. In the case under consideration the risk of loss was only normal, and as the work on the whole did not present apparent difficulties a contingency allowance of 5 per cent. was assumed and the price now amounts to 20s. 8½d. plus 2s. 4d. plus 5 per cent., or a total of 24s. 2d. per cwt. This figure is still further modified by taking into account the head, which gives 25s. 8½d. as the final result.

Fig. 6 shows the cylinder casting ready for delivery; the head was stopped off in way of the steam ports, and the joints of the draw-backs down the sides can also be clearly seen. These draw-backs were divided into sections over the length of the cylinder.

It is of interest to note that the weight of the casting was 9 tons 5 cwts. 1 qtr., with a deduction of 7 cwts. for the head returned, which gives a net weight of 8 tons 18 cwts. 1 qtr., against the estimated weight of 9 tons 6 cwts. gross and 8 tons 14 cwts. net, which was to the benefit of the job.

Unknown Factors

In the earlier part of this Paper reference was made to the judgment acquired after the arithmetical side of the estimate is finished. This covers the factors in the latter part of the example which has just been considered. It is, generally speaking, not possible to forecast at the estimating stage the class of pattern that may be received, particularly from a new customer, also the exact amount of wages for pattern attention, and the total amount of new gear necessary, especially in a jobbing foundry, where there is a continual variation in the work undertaken.

The selling price to be quoted may not altogether be comparable with that estimated, for it is an important condition that the estimator should have a complete knowledge of the market value of the work passing through his hands and be in a position to take advantage of the best terms that can be obtained.

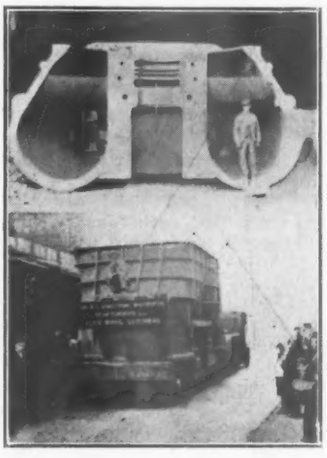


FIG. 8.—EXCEPTIONALLY HEAVY TYPE OF CASTING.

Commercial Considerations

It must be borne in mind when deciding on the selling price that the full loss on defective castings cannot be charged up to the customers, so that if the capacity or equipment of a foundry is such that a price could be quoted for any particular class of work which is well below that of competitors in the district, the estimator has the opportunity of counter-balancing possible losses on other sections of work, and ought to maintain a price just sufficiently low to obtain the order. In an estimating department records

(*Concluded on page 32.*)

GH 16794

Firm's Name

Description

Drg. Nos.

Order No.	Date	No. Off	No. Made

Pattern No.

Weight	Cwts	Qrs	Lbs
Estimate			
Delivered			
	£	s.	d.
Moulds			
Cores			
Total			
Mould Rate/Cwt.			
Cost per Cwt.			
Selling Price			

FIG. 7.—TYPE OF RECORD FOR FILING FOR FUTURE QUOTATIONS.

THE METALECTRIC-RUSS "DUPLEX" METHOD OF ELECTRICALLY MELTING AND SUPER HEATING CAST IRON

The latest form of electric melting—super heating cast iron—including addition of alloys, when required, for the production of high duty cast iron, has now been definitely established.

Plants supplied for a capacity from 2 cwt. to 3 tons. Cost of super heating less than 10/- per ton.

The discriminating Foundryman will realise that this is the most economical plant for producing high duty iron yet marketed.

WE MANUFACTURE A COMPLETE RANGE OF ELECTRIC FURNACES FOR MELTING AND ALL CLASSES OF HEAT TREATMENT.

Write now for further particulars and leaflets.

METALECTRIC FURNACES LTD.

SMETHWICK, BIRMINGHAM

LONDON OFFICE - - - - - 16, GROSVENOR PLACE, S.W.I.

which are easily and quickly accessible are essential, as a customer may require a price quickly for a repeat of an order, or a similar casting based on a previous job.

If reference again be made to Fig. 5, an example of such a record is given. This figure was reduced from the customer's print on to a loose leaf sheet of squared paper measuring 10 in. by 8 in. Only the principal dimensions and thickness are included, together with the full particulars of the estimate and final costs.

Only a short time is required for a junior employee to make this sketch, and it is well compensated for in the saving of storage space for drawings, etc. These records are only made for what are considered to be outstanding jobs of high total selling value. They also serve as a check on future estimates for similar work.

For the smaller class of work where a large number of different patterns is in operation, records are also kept of each job, but only consist of written particulars such as shown in Fig. 7. A card on which these details are printed is issued to the foundry foreman for all jobs, large or small, and the piece price for mould and cores together with the estimated weight is indicated.

It is the foreman's duty to make the best terms possible with his men and fix prices which are to their satisfaction, as well as his firm's, but not to exceed the figures given without special permission. The final prices arranged are entered on each card, which is returned to the office for inspection and completion, and filed as a record. It will be observed that all references to prices have dealt with piece work, but the principles of estimating are the same for time work with the adjustment for an increase of war bonus.

It is not intended in this Paper to discuss the comparative merits of piece and time work, but so far as estimating is concerned, it is a definite advantage to have an agreed price fixed in the early stages of the work, for the approximate cost is apparent as soon as the piece price is fixed. It may happen that although every care has been taken in preparing an estimate an unexpected difficulty may arise, perhaps in the way the pattern is made or some difficulty peculiar to a particular type of casting which only becomes evident from experience. If it be seen that the job will not be a profitable proposition, the best terms possible can be made, while there is still time to make some saving on the work.

The work of estimating for a foundry making practically all classes of castings rarely becomes monotonous, for the inquiries change from day to day, and although castings may be grouped into types, or classed in some convenient manner, there is invariably some point which calls for separate consideration.

Inquiries for a cast-iron bar weighing a few pounds or a casting such as that shown in Fig. 8 may be received. The estimate for the latter was made up in a corresponding manner to the example already given, with the exception that no heads were required. The weight of this casting was over 30 tons, and it was poured from three different points on the mould. At the stage whereat all the weights and wages are settled, the estimator's work on that job is finished until the actual weight and wages are checked up and records completed.

Incidentally, if it happens that a mistake be made in the moulding of any casting, which causes a waster, it is impossible for the estimator to assist. Neither is it possible for the foundry to make an under-estimated job pay.

No Swings or Roundabouts

It is sometimes argued that gains on one class of work compensate for losses on another; this may be so, but from the estimating point of view such an idea should not be entertained. Each job should stand alone, both in the case of wages paid and final costing. In poor trading periods, prices are cut, and there is a tendency to accept work at low figures and to fill the foundry with work to help the overheads. This is a procedure which should only be followed with caution. The amount by which a normal selling price can be reduced depends, of course, upon the corresponding reduction in overhead charges.

As part of the overheads are directly work charges, fluctuating with production, only general charges are to be considered. Therefore, the price can only be reduced to such level as will cover all works costs and possibly a percentage only of the standing charges.

The Buyer

While the buyer, justly or otherwise, complains of the variation in the prices quoted by the foundries, it is often in his power to alter this condition. For instance, if an inquiry be sent out which does not contain sufficient information to enable the estimator to arrive at a definite conclusion as to the actual requirements, it is obvious that a careful estimator will cover for a much higher contingency factor. Also, in cases where the drawing is such that a weight cannot be calculated, it is impossible for the estimator to offer the lowest price.

Telephoned inquiries should only be for repeat, or similar jobs, and be very carefully confirmed in case of variation if the order should mature, for it may happen that after quoting a price for certain castings, the order is received, and if it does not comply with the quotation, the whole question has to be reviewed, with the attending annoyance and waste of time.

In the North-East Coast area, one of the most common verbal inquiries is for propellers. The particulars given are generally the diameter and pitch, from which the estimator must assume the weight, irrespective of the fact that for, say, a 10-ft. dia. propeller weights of actual jobs have varied from 29 to 47 cwts., and a price has to be decided on, which would cover the worst case.

The buyer can also help to obtain a speedy reply to his inquiry by giving the weights of the castings when these are available. It has already been pointed out how the weight influences the price, so that it is necessary to calculate each weight fairly accurately, and when a number of estimates are in hand at one time, with perhaps an average of six castings each, a good deal of time could be saved.

Notes from the Branches

East Anglian Section.—A meeting was held on January 7 at the North East Essex Technical College and School of Art, Colchester, at which the chair was taken by Mr. M. W. Garside (Principal of the College).

The lecture entitled "Some Considerations of Cupola Operation," by MR. H. H. SHEPHERD, was presented by MR. J. L. FRANCIS, due to the unavoidable absence of the author, on whose behalf apologies were conveyed to the meeting. Apologies for non-attendance were also received from Mr. L. Tibbenham and Colonel Portway, Branch-President and Branch-Vice-President respectively.

The lecture was followed by a discussion in which many points of interest were raised. A vote of thanks to the author was proposed by ALDERMAN SANDERS, who was supported by MR. GARSIDE. MR. FRANCIS, in reply, said how disappointed Mr. Shepherd was at being unable to present his Paper personally. Mr. Francis also thanked Mr. T. E. Brazier and Mr. Garside for the efforts they had made towards the success of the meeting and for the permission to use the lecture hall and lantern.

ANOTHER STEEL FURNACE is to be put into operation at the Clydesdale Steelworks, Mossend, belonging to Stewarts and Lloyds, Limited.

Developments in the Production of Ingot-Mould Castings

(*Concluded from page 27.*)

They are used in turn. The diameter of the cupola shells is 84 in., but with standard bricks and auxiliary scone brick linings the melting zone diameter is 60 in. Two rows of tuyeres are incorporated, a bottom row of four and a top row of three. There are no outstanding modern innovations attached, but very effective service from these home-made melting furnaces is obtained.

The melting rate averages 14 tons per hour. It may be pointed out that the casting temperature is very low, at 1,175 deg. C., but the phosphorus content of the metal is likewise low at 0.03 per cent. On a cast of 150 tons, the consumption of coke per ton of metal melted averages 155 lbs., inclusive of the bed charge. The coke ratio to iron melted averages 1 to 14.

Care is taken to keep the tuyeres clean, and periodically to clean the wind belt, so that consistent melting is maintained. It is interesting to record that erosion to a depth of 8 in. in diameter is shown on examination of the melting zone after particularly heavy casts, but rarely is this amount exceeded.

Supplementary Illustrations

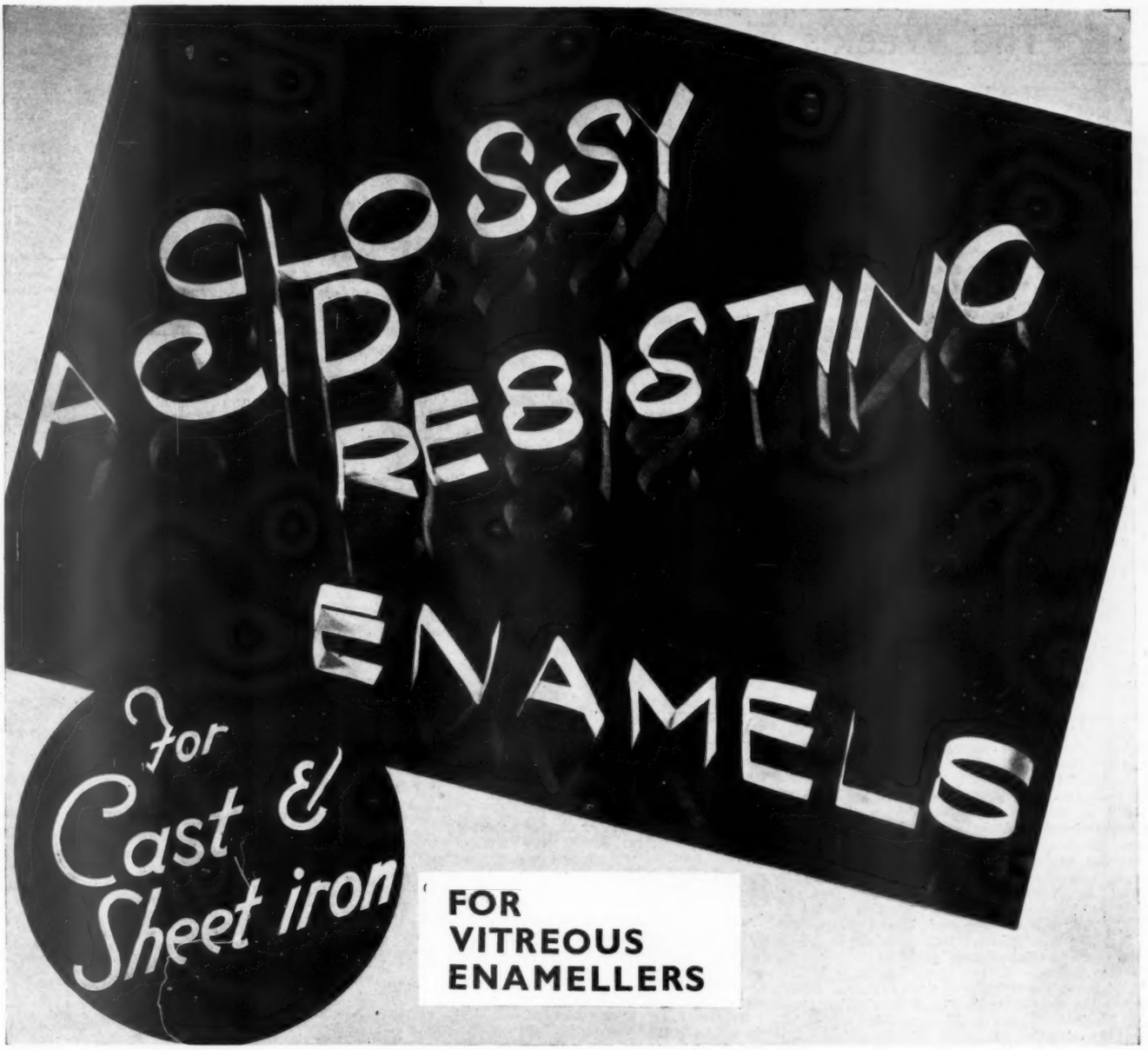
Fig. 15 shows an end view of the 26-ton casting actually made from the core shown on Fig. 5. The fluted effect is very distinct. In Fig. 16 the casting is shown in an upright position, the overall dimensions being clearly marked, whilst Fig. 17 is an angled view with metal given at 13 in. and conveys some idea of the exacting conditions to which the sand in service is subjected. Fig. 18 is an interior view of the main bay taken some years ago, whilst Fig. 19 shows a stock of approximately 2,000 tons of various ingot-mould castings in the stock yard ready for despatch. This photograph conveys a great deal more than one at first realises. The systematic stocking makes for easy despatch, and creates a tidy atmosphere. Moreover, the effect on the employees when they observe a minor operation well done is most effective.

When one bears in mind that 500 tons of castings can be made before defects in production become apparent, it will be recognised that every care must be exercised in manufacture. Fortunately, this position rarely arises. Ingot mould castings may be called heavy pieces of metal by those who are ignorant, but who will say that chilled or grained rolls, both plain in design, are other than high-class castings, subject to sévere service?

In conclusion the author desires to express his indebtedness to the directors of the Fullwood Foundry Company, Limited, for granting him permission to prepare this Paper, and he sincerely trusts that the younger men may be induced to give of their very best by contributing Papers to the Institute of British Foundrymen.

Catalogue Received

Refractory Concrete. A large amount of serious and reliable technical data have been included in a new catalogue issued by Lafarge Aluminous Cement Company, Limited, Lincoln House, 302, High Holborn, London, W.C.1. The various graphs have been neatly grouped and intelligently labelled and comprise a special section at the end of the book. The illustrations are splendidly displayed, whilst the letterpress has been carefully written to ensure progressive interest as one turns over the pages. The binding is of heavy red cardboard, and the whole aspect of the brochure proclaims a serious endeavour to apply a scientific background to everyday works problems.



The supplying of vitreous acid resisting enamels is a problem which has been tackled by our experts, who have studied the difficulties incurred by the usage of these enamels and have reduced them to a minimum.

Our Associated Company JAMES DAVIES (LONGTON), LTD., Ceramic Transfers, Berry Bank, Stafford Street, LONGTON, Stoke-on-Trent ***('Phone: 3343 'Grams: "Ceramic, Longton, Stoke-on-Trent"), will be pleased to supply suitable vitreous transfers for Cast and Sheet Iron.***

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The Week's News in Brief

Trade Talk

EXTENSIONS ARE BEING MADE to the foundry of the English Electric Company, Limited, at Stafford.

HURST, NELSON & COMPANY, LIMITED, have received an order from the South Indian Railway Company for 90 steel brake vans.

WILLIAM DOXFORD & SONS, LIMITED, Sunderland, have received an order from Morel, Limited, of Cardiff, for a 9,200-ton motor-vessel.

J. BROCKHOUSE & COMPANY, LIMITED, manufacturers of motor accessories, are to extend their new works in Livingstone Street, Clydebank.

SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED, Wallsend, have received an order from the Russian Government for a floating dock of 2,500 tons lifting capacity.

A. REYROLLE & COMPANY, LIMITED, Hebburn-on-Tyne, have received an order, valued at £20,000, from Sheffield Corporation, for the supply of substation switchgear.

WALKER & WILSON, LIMITED, Imperial Works, Hamilton, entertained its employees at a dance in the Town Hall on January 6, to mark the attainment of its silver jubilee.

BRITISH TIMKEN, LIMITED, Birmingham, have been placed on the Admiralty List for the supply of ball and parallel roller bearings, in addition to their range of tapered roller bearings.

A NEW REFRACTORY BRICKWORKS which has been erected by the Bonnybridge Silica & Fireclay Company, Limited, near Airdrie, Lanarkshire, will go into production at the end of this month.

MOULDERS EMPLOYED at the Chattan Foundry, Bonnybridge, of Mitchell, Russell & Company, Limited, have commenced a system whereby they receive a daily supply of bottled milk while at work.

THE CITY OF BIRMINGHAM has published a tourist brochure which is superior to the majority of those issued by Continental centres. It is available on request to the Information Bureau, Council House, Birmingham, 1.

VICKERS-ARMSTRONGS, LIMITED, have acquired the goodwill of the Jarrow galvanising works, which are being closed, and the 50 men employed at the Jarrow plant are being transferred to the firm's galvanising works at Hebburn.

IRON AND STEEL CONSUMPTION in Sweden in January to November totalled 860,000 tons, as against 756,100 tons in the corresponding period of 1935. Production, export and import figures for the first eleven months of 1936 were all in excess of the corresponding figures for 1935.

BARCLAY, CURLE & COMPANY, LIMITED, Whiteinch, Glasgow, are to build an 8,000-ton cargo motorship for the British India Steam Navigation Company, Limited. The propelling machinery, consisting of Barclay-Curle-Doxford Diesel engines, will be constructed by the North British Locomotive Company, Limited.

THE TENDER of the British Thomson-Houston Company, Limited, to install a 25,000-kw. turbo-alternator at Pinkston Power Station has been recommended for acceptance by Glasgow Transport Committee. The tender includes condensing plant and auxiliaries to be supplied by G. & J. Weir, Limited, of Cathcart, Glasgow.

ON JANUARY 1 the provincial monopolies controlling the production and marketing of antimony and tungsten in China came under the control of the Central Government in Nanking. China is estimated to produce about 70 per cent. of the world's supply of antimony, and about 65 per cent. of that of tungsten; steps are now being taken to intensify production.

HENRY EDIE & COMPANY, LIMITED, of the Bow Foundry, London, E.3, have now transferred their business to a new modern foundry at Beckton Road, E.6. Owing to a large shipping connection, the change-over had to be effected without missing a day's cast, and this problem was successfully coped with. The Bow Foundry had been in operation over 120 years.

E. H. JONES (MACHINE TOOLS), LIMITED, have been appointed sole agents in Great Britain for Alfred H. Schutte, Cologne, Germany, as from January 1, 1937. Apart from a complete range of automatics, the Schutte line of machine tools also includes semi-automatic chucking machines, boring and turning machines, cutter grinding machines, broaching machines and electric furnaces.

THE PARTNERSHIP between Messrs. Joseph Robinson, William Hewitt and Stanley Beatty, carrying on business as iron and non-ferrous castings manufacturers and wood patternmakers and joiners, under the style of the Brimsdown Castings Company, has been dissolved by mutual consent. Debts will be received and paid by Messrs. W. Hewitt and S. Beatty, who will continue the business under the same style.

Contracts Open

Bishop's Stortford, February 8.—Spun-iron water mains and castings, for the Urban District Council. The Surveyor, The Council House. (Fee £2 2s., returnable.)

Johannesburg, February 22.—300 tons (of 2,000 lbs.) cold blast pig-iron; 800 tons hematite No. 1, for iron-foundry; 1,500 tons hematite No. 1, for steel-foundry; 25 tons ferro-managanese, 78/80 per cent., for the South African Railways and Harbours Administration. Tenders endorsed "Tender No. 1192, Pig-Iron" to the secretary to the Tender Board, South African Railway Headquarter Offices, Johannesburg

Rushden, January 23.—Steel tubular pattern lamp standards, for the Urban District Council. The Surveyor, Council Buildings.

Smethwick, January 20.—Castings, for the Town Council. Mr. R. Fletcher, borough engineer and surveyor, Council House.

Torquay, February 5.—Castings, iron and steel, tools, implements, etc., for the Torquay Corporation. The Borough Engineer, Town Hall.

Bishop's Stortford, February 8.—Electrically-driven horizontal turbine pumping plant of 30,000 galls. per hr. capacity, for the Urban District Council. The Surveyor, Council Offices. (Fee £2 2s., returnable.)

Swansea, January 26.—Cables, castings, and transformers, for the Town Council. The Borough Electrical Engineer, Guildhall.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Berryhill Fireclay & Coal Company, Limited, 126, High Street, Falkirk.—Capital, £3,000.

Ergos Engineering Company, Limited, Premier House, 150, Southampton Row, London, W.C.1.—Capital, £5,000. To carry on the business of electro-metallurgy in all its branches, etc.

British Lead Mills, Limited.—Capital, £75,000. To take over the business of lead manufacturers and metal workers carried on by Brilmill, Limited, at Welwyn Garden City, Herts, and elsewhere (formerly the British Lead Mills, Limited). Directors: P. Blenkinsop, F. G. Martin, R. S. H. Shepard, and A. G. Martin.

Company Meeting

The annual meeting of Cannon Iron Foundries, Limited, was held at Deepfields, Bilston, on December 31. MR. G. A. LEITCH (chairman) said that the profit on trading, £76,946, was £3,350 higher than for 1935, and the net profit for the year had increased by approximately the same amount. This satisfactory result was directly due to a considerable increase in the volume of their turnover, the sales for the year having exceeded all previous figures in the history of the business, notwithstanding that their price level remained unchanged in comparison with that of the previous year. The maximum benefit from the extra turnover was not obtained, by reason of the rising costs of raw materials—particularly pig-iron and fuel—and of wage increases under the national agreement. They were able to reduce to some extent the burden of such increases this year by carrying heavier stocks and enlarging their forward contracts, and while production costs would undoubtedly be higher during the ensuing year, increased selling prices had become effective during the last few weeks, and would partially restore the margin of gross profit.

Personal

SIR HOLBERRY MENSFORTH has resigned from the board of the English Electric Company, Limited.

MR. G. BAKER has retired after 50 years' service with the Shelton Iron, Steel & Coal Company, Limited.

MR. AND MRS. ALEXANDER SAMSON, of Newmains, have celebrated their golden wedding. Mr. Samson has been in the employ of the Coltness Iron Company, Limited, for 59 years.

MAJOR CLIFFORD HOWE, Mr. Wilfred Edgar Hale, Capt. John Izon Chesshire, Mr. John Ernest Legge and Capt. Cyril William Parkes are among members of the iron and steel and hardware manufacturing trades of South Staffordshire whose names have been added to the Commission of the Peace for the County of Stafford.

MR. AND MRS. WILLIAM MATHIESON, of Horsforth, near Leeds, have just celebrated their diamond wedding. Mr. Mathieson, who is a director of Wilsons & Mathiesons, Limited, Leeds, was one of the founders of the National Light Castings Association and the National Light Castings Federation, of which he was chairman for some years. His family's connection with ironfounding dates back to 1795.

Will

COTTERILL, GEORGE THOMAS, secretary of the Butterley Company, Limited, Derby £9,444

Obituary

MR. HARRY KENYON, who died on December 31, aged 61, at his home at Loxley, Sheffield, was a director of W. Kenyon & Sons (Loxley), Limited, steel rollers.

MR. WILLIAM WARD BOYLE CLAYTON, son of Mr. W. W. W. Clayton, managing director of Hudswell, Clarke & Company, Limited, locomotive engineers, Leeds, died recently.

MR. WALTER KENDRICK, who for twenty years has been general manager of the Ridgacre Foundry Company, Limited, Church Lane, West Bromwich, died on January 7. He was in his sixty-ninth year.

Forthcoming Events

JANUARY 18.

Sheffield Society of Engineers and Metallurgists:—"Modern Aspects of Ferrous Metallurgy," Presidential Address by Prof. J. H. Andrew, D.Sc., at Mappin Hall, St. George's Square, Sheffield, at 7.30 p.m.

JANUARY 19.

Iron and Steel Institute:—Joint Meeting with the Staffordshire Iron and Steel Institute. "Controlled Grain Size in Steel," Paper by T. Swinden and G. R. Bolsover, at the Imperial Hotel, Birmingham, at 7 p.m.

Institute of British Foundrymen

JANUARY 16.

Falkirk Section:—"Porosity in Castings." Paper by Prof. R. Hay, at the Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

West Riding of Yorkshire Branch:—Annual Dinner and Dance, at 6.30 p.m.

JANUARY 21.

East Anglian Section:—Annual Dinner, at Crown and Anchor Hotel, Ipswich, at 7 p.m.

JANUARY 23.

Birmingham, Coventry and West Midlands Branch:—Annual Dinner and Dance, at the Botanical Gardens, Edgbaston, Birmingham.

East Midlands Branch:—Joint meeting with the Lincolnshire Section. "A Refresher in Cast Iron Metallurgy," Paper by A. E. Peace, at the University College, Nottingham, at 6 p.m.

Newcastle-upon-Tyne Branch:—"Further Developments with Coal Dust in Moulding Sands," Paper by B. Hird, at Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

Wales and Monmouth Branch:—Joint meeting with the Newport Metallurgical Association. "Ingot Moulds and Heavy Castings," Paper by J. Roxburgh, at the Technical College, Newport, at 6.30 p.m.

JANUARY 26.

Scottish Branch:—Joint meeting with the Institution of Engineers and Shipbuilders in Scotland. "Cast Iron and its Application to Engineering," Paper by A. Campion, F.I.C., at the Institution of Engineers and Shipbuilders, Elmsbank Crescent, Glasgow, at 7.30 p.m.

The Institute of Vitreous Enamellers

JANUARY 23.

Midland Section:—"Colour Measurement," Paper by J. M. Preston, at the Chamber of Commerce, New Street, Birmingham, at 7.30 p.m.

THE "ROCKET" CORE MAKING MACHINES

HELP to . . .

REDUCE COSTS AND MAKE SOUND CASTINGS

for

BRITISH

— STEEL FOUNDERS —
GREY IRON FOUNDERS
MALLEABLE FOUNDERS
NON-FERROUS FOUNDERS

used in the manufacture of—

Electric Cookers. Gas Cookers. Motor Transport Vehicles. Aeroplanes. Internal Combustion Engines. Cast Iron Bath Fittings. Brass Water Service Fittings. Sluice Valves. Gas Valves. Rain Water Castings. Textile Machinery. Lawn Mowers. Ship Building, etc., and General Engineering Castings.

FOUNDRY ENGINEERS LIMITED

HALIFAX — YORKS.

Telephone: Halifax 61459. Telegrams: "FEL," Halifax.

Raw Material Markets

The increases in the prices of iron and steel materials have made little or no difference to the demand. Outputs are being enlarged, but as extra material comes on to the market it is immediately taken up. The price of basic pig-iron has been advanced by 7s. 6d. per ton in all districts.

Pig-Iron

MIDDLESBROUGH. — Makers continue to despatch all supplies of foundry iron as they become available, but deliveries are badly in arrears. Any new business is restricted to deliveries in the first half of the year only. The official minimum prices of No. 3 Cleveland G.M.B. are 81s. in the Middlesbrough area, 83s. elsewhere on the North-East Coast, 84s. on the Scottish East Coast, and 87s. on Clydeside. The quotation for basic pig-iron has been advanced by 7s. 6d. per ton. The new price is 82s. 6d., less 5s. per ton rebate. No supplies are available on the open market, and so the price remains nominal.

The recently advanced quotations for hematite have not prevented a heavy flow of orders, but, the supply position being what it is, many of these cannot be accepted. Each Coast mixed numbers are quoted at 97s. 6d. for delivery on the North-East Coast, 103s. in Sheffield, and 108s. 6d. per ton in the Midlands, subject to a rebate of 5s. per ton.

LANCASHIRE. — Most of the activity in this area concerns the despatch of deliveries against existing contracts, there not being very many inquiries for new business. This is a result of the majority of consumers having covered their needs for the first six or nine months of the year. Offers of Staffordshire and Derbyshire brands of No. 3 foundry iron for delivery to users in the Lancashire price zone are on the basis of 89s. per ton, with Northamptonshire at 87s. 6d. and Derbyshire forge iron at from 84s. to 86s., according to the class of consumer. For delivery to users in the Manchester district, Scottish foundry iron is quoted at 105s. per ton, with West Coast hematite at 106s. and East Coast material at 105s. 6d., both subject to a rebate of 5s. per ton.

MIDLANDS.—Only a small amount of new business has been transacted during the past week—not through any decline in the demand, but because many consumers have already covered their needs and, further, owing to the unwillingness of producers to extend their commitments. Midland qualities of ordinary foundry No. 3 are 83s. 6d. for Northants material and 86s. for Derbyshire and Lincolnshire iron, including delivery to Birmingham and Black Country stations and subject to a small sliding-scale rebate to large consumers. The new price of basic iron is £4 7s. 6d. per ton, less rebate. The quotation for forge iron is 5s. per ton below No. 3 foundry, and there is a heavy demand at this level. Users of the special irons are well employed and large tonnages are being inquired for. Medium-phosphorus iron is quoted at 90s. to 95s., low-phosphorus from 97s. 6d. to 107s. 6d. and refined iron from £6 5s. to £7 15s., delivered the Midlands. The shortage of supplies in the hematite market is still acute and makers are not anxious to accept further orders. West Coast mixed numbers are at £5 9s. 6d., East Coast No. 3 at £5 8s. 6d., and Welsh mixed numbers at £5 8s., delivered the Midlands. An extra 1s. 6d. per ton is charged if delivery into works is desired.

SCOTLAND.—There has been a general resumption of work this week following the new year vacation. An increase in the price of basic iron of 7s. 6d. per ton has been announced, making the figure 82s. 6d., less 5s. rebate, f.o.t. steelworks. Owing to the lack of iron, however, the price remains purely nominal. No. 3 foundry is still quoted at 88s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. Light-castings founders are excellently situated for work. The price of No. 3 Cleveland iron is 84s. f.o.t. Falkirk and 87s. f.o.t. Glasgow, with Northamptonshire No. 3 1s. 3d. per ton less than the foregoing figures. Hematite mixed numbers are quoted at 98s., less 5s. rebate, delivered. Good deliveries have been made to local steelworks.

Coke

There is an insistent demand for deliveries on the foundry-coke market, and in some cases coke ovens are in arrears. Prices display a rising tendency and are firm. For delivery in Birmingham and district, best Durham coke is offered at from 42s. 6d. to 45s., with Welsh coke from 39s. 6d. to 54s., according to quality and quantity.

Steel

Although business in the steel market has become less active since the New Year, it is because the works have been obliged to adopt a cautious policy with regard to accepting new business owing to the crowded state of their order-books, says the official report of the London Iron and Steel Exchange. There has been no slackening in the actual demand, which appears inclined to expand, and export business is offering in larger quantities than the British industry is able to handle. The situation in the semi-finished steel department is particularly difficult, since no supplies of the qualities most in demand are available for the open market. The producing works have sold their output for several weeks to come, and it appears difficult to obtain additional quantities from foreign sources. Business in finished steel is offering in greater tonnages than the works can deal with, although the latter are working at full capacity, and there seems little doubt that the output for the current year will exceed that of 1936. Export business is difficult to arrange, owing to the insatiable home demand, although a large inquiry has been received lately from most of the oversea markets.

Scrap

The Cleveland market remains fully active, and works are taking up heavy deliveries. The forward trend of prices is uncertain, and is preventing merchants from entering into any substantial amount of new business. For delivery to Tees-side works the price of heavy steel scrap is 62s. 6d. per ton. Machinery metal at 72s. 6d. and heavy foundry cast-iron scrap at 70s. are receiving numerous inquiries, and prices are expected to advance in the near future. The question of prices is also a problem on the Midland market, and, until the position becomes clearer, business will remain quiet. There is an insistent call for deliveries against existing contracts. Heavy steel in furnace sizes is at 57s. 6d., with mixed heavy iron and steel at 55s. Heavy, unsheared wrought iron at 70s. is only nominal. Short, heavy steel, suitable for foundry purposes, is at 70s. per ton, delivered works. Heavy tonnages of all qualities are being sold on the Scottish market at firm prices. First-quality heavy steel scrap is now 62s. 6d., for quantities of 100 tons and up, while heavy basic is 5s. per ton less. There is a very active inquiry for good, piling, wrought-iron scrap at 72s. 6d., with 2s. 6d. to 3s. 6d. per ton more for lots of special quality. Heavy machinery cast-iron scrap, in pieces not exceeding 1 cwt., is firm at 72s. 6d. to 73s. 6d., with ordinary cast-iron scrap, to the same specification, at 67s. 6d. to 68s. 6d. per ton, delivered f.o.t. consumers' works.

Metals

Copper.—Although there is no official confirmation it is understood that the copper-producing countries have decided to discontinue the agreement for restricting output. This report caused 6,000 tons to be thrown on the market. The information originated from London Metal Exchange dealers. Industrial concerns in this country are active and the demand for copper is likely to be on a heavy scale. Particularly is this expected in the case of the armament manufacturers. Continental trade continues to be weakened by the civil war in Spain, while the labour disputes in the United States are restricting business in a market which, otherwise, is very brisk.

Daily market prices :—

Cash.—Thursday, £49 10s. to £49 11s. 3d.; Friday, £50 8s. 9d. to £50 11s. 3d.; Monday, £53 to £53 2s. 6d.; Tuesday, £51 8s. 9d. to £51 11s. 3d.; Wednesday, £54 5s. to £54 6s. 3d.

Three Months.—Thursday, £49 13s. 9d. to £49 15s.; Friday, £50 13s. 9d. to £50 15s.; Monday, £53 2s. 6d to £53 5s.; Tuesday, £51 12s. 6d. to £51 13s. 9d.; Wednesday, £54 5s. to £54 6s. 3d.

Tin.—Rather quiet conditions have again prevailed in this market and buyers have shown little active interest. The decision of the International Tin Committee with regard to the new restriction scheme had been fully expected, and thus little disturbance was caused. Perhaps the most important item in the text of the new scheme is the fact that majority voting will govern future quota decisions. The critical labour situation in the United States has been reflected in the market there, and demand has shown a small decline.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £230 15s. to £231; Friday, £231 5s. to £231 10s.; Monday, £230 10s. to £230 15s.; Tuesday, £230 10s. to £231; Wednesday, £231 to £231 10s

Three Months.—Thursday, £231 10s. to £231 15s.; Friday, £232 to £232 5s.; Monday, £231 10s. to £231 15s.; Tuesday, £231 10s. to £231 15s.; Wednesday, £231 15s. to £232.

Spelter.—Trade interest in spelter continues to be affected by the seasonal quietness. The weekly market report issued by Brandeis, Goldschmidt & Company, Limited, states that "the statistical position of this metal has of late tended to improve, and the recent advance in price has not only been in sympathy with the advances which have taken place in the prices of other base metals, but is the result of a better consumption, which has recently more than taken care of production. The speculative account in spelter has, in view of the present liquidations, become healthier and price movements are likely to become less violent."

Official quotations were as follow :—

Ordinary.—Thursday, £19 6s. 3d.; Friday, £20; Monday, £20 13s. 9d.; Tuesday, £21 18s. 9d.; Wednesday, £22 15s.

Lead.—The undertone of the market remains very satisfactory, in spite of the temporary lull in demand. Consumption is reported to be well maintained. On the Continent, the Spanish civil war continues to be a source of anxiety. Outputs in Spain are irregular. Many of the mines have been in the hands of the Madrid Government at one time and have then passed to the control of the militarists. Thus operations have been at sixes and sevens. More or less normal conditions have prevailed at mines which have remained in Government territory. The American Bureau of Metal Statistics estimates the world's output of lead during November at 145,200 short tons, as against 128,800 tons in October. These figures are exclusive of Italian and Spanish outputs.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £27 7s. 6d.; Friday, £27 11s. 3d.; Monday, £28 3s. 9d.; Tuesday, £28 5s.; Wednesday, £28 11s. 3d.

Company Reports

Thomas Bolton & Sons, Limited.—Interim dividend of 2½ per cent.

Hale & Hale (Tipton), Limited.—Statutory report states that total number of shares allotted is 200,000 5½ per cent. cumulative preference shares of 10s. each and 399,600 ordinary shares of 5s. each, all of which have been allotted credited as fully paid up in payment of purchase consideration payable under agreement between Thomas L. Hale (Tipton), Limited, W. E. Hale, T. L. Hale, and the company. The remaining 400 ordinary shares have been allotted for cash.

Production of Black Anodic Coatings on Tin.—Some time ago the International Tin Research and Development Council developed a method of producing colourless films on tin by an anodic process. Like the corresponding films on aluminium these films are capable of being dyed in various colours and have decorative possibilities. The Council's director of research, Mr. D. J. Macnaughtan and Dr. R. Kerr have extended this work and describe in Technical Publication, Series A, No. 48, how black films may be prepared without recourse to dyeing. The tin or tin-alloy article to be coated is made the anode in a hot solution containing tervalent or quadrivalent anions such as phosphates or ferricyanides using high current density. About six minutes' treatment at 90 deg. C. suffices for a satisfactory blue-black coating on an article of simple contour. The decoration is also suitable for tinplate or pewter. Copies of the publication may be obtained, free of charge, from the International Tin Research and Development Council, Manfield House, 378, Strand, London, W.C.2.

For **"easy stripping"** use

YORKSHIRE SAND

Yorkshire Sand is of a synthetic nature, its production being under careful laboratory control. Perfect standardization is obtained with the various grades, suitable for light and the heaviest steel castings.

It is because of the refractoriness of the sand and of the toughness of the mould surface that castings made with Yorkshire Sand are distinguishable by their excellent finish.

Please address all enquiries to the nearest Sales Office :

GENERAL REFRACTORIES LTD.,

Genefax House, Sheffield

Telephone : *Sheffield 31113 (6 lines).*

Telegrams : *"Genefax, Sheffield."*

LONDON OFFICE:	SCOTTISH OFFICE:	SOUTH WALES OFFICE:	MANCHESTER OFFICE:
Russell House, Adelphi, W.C.2.	156, St. Vincent St., Glasgow.	11, Wind St., Swansea.	9, Albert Square, Manchester, 2.
Telephone: Temple Bar 7361.	Telephone: 5250.	Telephone: 3680.	Telephone: Blackfriars 6130.
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★

Read what an IMPORTANT STEELFOUNDER says :—

"During the 40 years I have been connected with Steel Foundry work, considerable changes have taken place. Away back, we had Steel Moulders' Composition, Old Crucible Pots, etc., and each works claimed to have its own 'secret' moulding composition. High Silica Sand has eliminated practically all these from many foundries and to-day we have your 'Yorkshire Sand' which acts almost like a chill, and leaves the skin of the casting blue-black and as clean as cast iron.

The hot steel lies quietly against the wall of sand, and often when the casting has been lifted out of the mould, the latter looks as if it could be used over again, just like a permanent mould."

RAW MATERIALS—PRICE LIST

(Wednesday, January 13, 1937)

COPPER

	£	s.	d.
Standard cash	54	5	0
Three months	54	5	0
Electrolytic	59	0	0
Tough	58	1	3
Best selected	58	10	3
Sheets	87	16	3
India	67	16	3
Wire bars	59	16	3
Ingot bars	59	16	3
H.C. wire rods	63	6	3
Off. av. cash, Dec.	45	19	$8\frac{4}{11}$
Do., 3 mths., Dec.	46	5	$10\frac{10}{11}$
Do., Sttlmnt., Dec.	45	19	$6\frac{8}{11}$
Do., Electro, Dec.	50	13	9
Do., B.S., Dec.	50	13	0
Do., wire bars, Dec.	51	0	$2\frac{8}{11}$
Solid drawn tubes			$12\frac{3}{4}$d.
Brazed tubes			$12\frac{1}{4}$d.
Wire			8d.

BRASS

Solid drawn tubes	$11\frac{1}{2}$d.
Brazed tubes	$13\frac{1}{2}$d.
Rods, drawn	10d.
Rods, extd. or rlld.	6d.
Sheets to 10 w.g.	$9\frac{1}{2}$d.
Wire	$9\frac{1}{2}$d.
Rolled metal	$8\frac{7}{8}$d.
Yellow metal rods	6d.

TIN

	£	s.	d.
Standard cash	231	0	0
Three months	231	15	0
English	231	5	0
Bars	233	5	0
Straits	233	10	0
Australian	231	0	0
Eastern	233	12	6
Banca	233	0	0
Off. av. cash, Dec.	232	5	$1\frac{4}{11}$
Do., 3 mths., Dec.	232	4	$9\frac{11}{11}$
Do., Sttlmt., Dec.	232	5	$8\frac{9}{11}$

SPELTER

	£	s.	d.
Ordinary	22	15	0
Remelted	19	10	0
Hard	21	0	0
Electro 99.9	24	13	9
English	23	5	0
India	19	10	0
Zinc dust	25	10	0
Zinc ashes	6	0	0
Off. aver., Dec.	18	1	$0\frac{3}{11}$
Aver. spot, Dec.	17	19	$11\frac{7}{22}$

LEAD

	£	s.	d.
Soft foreign ppt.	28	11	3
Empire	29	0	0
English	30	10	0
Off. aver., Dec.	25	10	$7\frac{1}{2}$
Aver. spot, Dec.	25	11	$2\frac{7}{11}$

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.		£	s.	d.
Zinc sheets, English	32	5	0	to 32	15	0	
Do., V.M. ex-whse.	32	5	0	to 32	15	0	
Rods				34	0	0	

ANTIMONY

	£	s.	d.		£	s.	d.
English	75	0	0	to 76	0	0	
Chinese, ex-whse.				62	10	0	
Crude, c.i.f.				34	0	0	

QUICKSILVER

	£	s.	d.
Quicksilver	14	2	6

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.		£	s.	d.
Ferro-silicon—							
25%	8	17	6				
40/50%	11	0	0	to 12	5	0	
75%	16	2	6	to 17	7	6	
Ferro-vanadium—							
35/50%	12/8 lb. Va						
Ferro-molybdenum—							
70/75% carbon-free	4/6 lb. Mo.						
Ferro-titanium—							
20/25% carbon-free	9d. lb.						
Ferro-phosphorus, 20/25%	£21 to £22						
Ferro-tungsten—							
80/85%	3/- lb.						
Tungsten metal powder—							
98/99%	3/1½ lb.						
Ferro-chrome—							
2/4% car.	33	0	0				
4/6% car.	21	10	0				
6/8% car.	21	0	0				
8/10% car.	21	0	0				
Ferro-chrome—							
Max. 2% car.	33	10	0				
Max. 1% car.	36	5	0				
Max. 0.5% car.	37	5	0				
70% carbon-free	9½d. lb.						
Nickel—99.5/100%	£180 to £185						
"F" nickel shot	£165	0	0				
Ferro-cobalt, 98/99%	7/3 lb.						
Metallic chromium—							
96/98%	2/5 lb.						
Ferro-manganese—							
76/80% loose	£11	15	0	to 12	5	0	
76/80% packed	£12	15	0	to 13	5	0	
76/80% export	£10	15	0				
Metallic manganese—							
94/96% carbon-free	1/3 lb.						

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{7}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	3	5	0				
Mixed iron and steel	3	1	0	to 3	3	0	
Heavy cast iron	3	0	0				
Good machinery	3	5	0				
Cleveland—							
Heavy steel	3	2	6				
Steel turnings	2	5	0				
Heavy cast iron	3	10	0				
Heavy machinery	3	12	6				
Midlands—							
Light cast-iron scrap	2	15	0	to 2	17	6	
Heavy wrought iron	3	10	0				
Steel turnings	2	0	0	to 2	2	6	
Scotland—							
Heavy steel	3	2	6				
Ordinary cast iron	3	7	6	to 3	8	6	
Engineers' turnings	2	7	6				
Cast-iron borings	2	2	6				
Wrot-iron piling	3	12	6				
Heavy machinery	3	12	6	to 3	13	6	

London—Merchants' buying prices, delivered yard.

	£	s.	d.		£	s.	d.
Copper (clean)	42	0	0				
Brass	24	10	0				
Lead (less usual draft)	25	0	0				
Tea lead	20	0	0				
Zinc	12	0	0				
New aluminium cuttings	74	0	0				
Braziery copper	40	0	0				
Gunmetal	40	0	0				
Hollow pewter	170	0	0				
Shaped black pewter	124	0	0				

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	83/6
,, No. 3	81/–
,, No. 4	80/–
Forge No. 4	80/–
Hematite No. 1	98/–*
Hematite M/Nos.	97/6*
N.W. Coast—	
Hem. M/Nos. d/d Glas.	98/–*
,, d/d Birm.	109/6*
Malleable iron d/d Birm.	—
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	83/–
,, No. 3 fdry.	86/–
Northants forge	80/6
,, fdry. No. 3	83/6
,, fdry. No. 1	86/6
Derbyshire forge	83/–
,, fdry. No. 3	86/–
,, fdry. No. 1	89/–
Scotland—	
Foundry, No. 1, f.o.t.	90/6
,, No. 3, f.o.t.	88/–
Cleveland No. 3, Glasgow	87/–
,, ,, Falkirk	84/–
Scottish hem. M/Nos. d/d	98/–*
Sheffield (d/d district)—	
Derby forge	80/6
,, fdry. No. 3	83/6
Lincs forge	80/6
,, fdry. No. 3	83/6
W.C. hematite	103/6*
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	89/–
Staffs fdry. No. 3	89/–
Northants fdry. No. 3	87/6
Cleveland fdry. No. 3	89/–
Glengarnock, No. 3	105/–
Clyde, No. 3	105/–
Monkland, No. 3	105/–
Summerlee, No. 3	105/–
Eglinton, No. 3	105/–
Gartsherrie, No. 3	105/–
Shotts, No. 3	105/–

* Subject to a rebate of 5s. per ton under certain conditions.

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.		£	s.	d.
Iron—							
Bars (cr.)	10	10	0				
Nut and bolt iron	8	17	6	to 9	7	6	
Hoops	11	7	6	and up.			
Marked bars (Staffs) f.o.t.	13	0	0				
Gas strip	11	7	6	and up.			
Bolts and nuts, ¼ in. × 4 in.	16	0	0	and up.			
Steel—							
Plates, ship, etc.	9	10	6	to 9	13	0	
Boiler plts	10	0	6	to 10	3	0	
Chequer plts.	11	3	0				
Angles	9	3	0				
Tees	10	3	0				
Joists	9	3	0				
Rounds and squares, 3 in. to 5½ in.	10	3	0				
Rounds under 3 in. to ⅜ in. (Untested)	9	10	0				
Flats—8 in. wide and over	9	8	0				
,, under 8 in. and over 5 in.	9	13	0				
Rails, heavy	8	5	0	to 8	10	0	
Fishplates	12	10	0				
Hoops (Staffs)	10	5	0				
Black sheets, 24g. (4-t. lots)	12	0	0				
Galv. cor. shts. (,,)	14	0	0				
Galv. flat shts. (,,)	14	10	0				
Galv. fencing wire, 8g. plain	15	10	0				
Billets, soft	6	5	0				
Sheet bars	6	2	6	to 6	10	0	
Tin bars	6	2	6	to 6	10	0	

PHOSPHOR BRONZE

	Per lb. basis
Strip	12d.
Sheet to 10 w.g.	13d.
Wire	$14\frac{1}{2}$d.
Rods	14d.
Tubes	16d.
Castings	14d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	22.31
No. 2 foundry, Valley	20.50
No. 2 foundry, Birm.	16.88
Basic, Valley	20.00
Malleable, Valley	20.50
Grey forge, Valley	20.00
Ferro-mang. 80%, seaboard	80.00
O.-h. rails, h'y, at mill	39.00
Billets	34.00
Sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Chicago	2.15
Steel bars	2.20
Tank plates	2.05
Beams, etc.	1.90
Skelp, grooved steel	1.80
Steel hoops	1.95
Sheets, black, No. 24	2.80
Sheets, galv., No. 24	3.40
Wire nails	2.25
Plain wire	2.60
Barbed wire, galv.	2.70
Tinplates, 100-lb box	$4.85

COKE (at ovens)

Welsh foundry	30/– to 32/6
,, furnace	24/6 to 25/–
Durham foundry	24/3 to 25/–
,, furnace	21/3 to 22/–
Scotland, foundry	28/–
,, furnace	—

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	19/9 to 20/3
,,	28×20 ,,	39/6 to 40/–
,,	20×10 ,,	28/– to 28/3
,,	18¾×14 ,,	20/6 to 21/–
C.W.	20×14 ,,	16/6 to 17/3
,,	28×20 ,,	35/6 to 35/9
,,	20×10 ,,	23/9 to 24/–
,,	18¾×14 ,,	17/3 to 17/6

SWEDISH CHARCOAL IRON & STEEL

	£	s.	d.		£	s.	d.
Pig-iron	£7	0	0	to	£8	0	0
Bars-hammered, basis	£16	0	0	to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0	to	£16	0	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£26	0	0	to	£29	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£11	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
Jan.	7 ..	49	10	0	inc.	12/6
,,	8 ..	50	8	9	,,	18/9
,,	11 ..	53	0	0	,,	51/3
,,	12 ..	51	8	9	dec.	31/3
,,	13 ..	54	5	0	inc.	56/3

Electrolytic Copper

		£	s.	d.		
Jan.	7 ..	54	5	0	inc.	10/-
,,	8 ..	55	0	0	,,	15/-
,,	11 ..	57	5	0	,,	45/-
,,	12 ..	56	0	0	dec.	25/-
,,	13 ..	59	0	0	inc.	60/-

Standard Tin (cash)

		£	s.	d.		
Jan.	7 ..	230	15	0	inc.	40/-
,,	8 ..	231	5	0	,,	10/-
,,	11 ..	230	10	0	dec.	15/-
,,	12 ..	230	10	0	No change	
,,	13 ..	231	0	0	inc.	10/-

Tin (English ingots)

		£	s.	d.		
Jan.	7 ..	230	15	0	inc.	35/-
,,	8 ..	231	5	0	,,	10/-
,,	11 ..	230	15	0	dec.	10/-
,,	12 ..	230	15	0	No change	
,,	13 ..	231	5	0	inc.	10/-

Spelter (ordinary)

		£	s.	d.		
Jan.	7 ..	19	6	3	inc.	7/6
,,	8 ..	20	0	0	,,	13/9
,,	11 ..	20	13	9	,,	13/9
,,	12 ..	21	18	9	,,	25/-
,,	13 ..	22	15	0	,,	16/3

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
Jan.	7 ..	21	6	3	inc.	16/3
,,	8 ..	22	1	3	,,	15/-
,,	11 ..	22	13	9	,,	12/6
,,	12 ..	23	17	6	,,	23/9
,,	13 ..	24	13	9	,,	16/3

Lead (soft foreign, prompt)

		£	s.	d.		
Jan.	7 ..	27	7	6	inc.	16/3
,,	8 ..	27	11	3	,,	3/9
,,	11 ..	28	3	9	,,	12/6
,,	12 ..	28	5	0	,,	1/3
,,	13 ..	28	11	3	,,	6/3

Lead (English)

		£	s.	d.		
Jan.	7 ..	29	10	0	inc.	15/-
,,	8 ..	29	10	0	No change	
,,	11 ..	30	0	0	inc.	10/-
,,	12 ..	30	0	0	No change	
,,	13 ..	30	10	0	inc.	10/-

AVERAGE MONTHLY PRICES OF RUBIO ORE (MIDDLESBROUGH).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	0 15 3	0 15 6	0 15 3	0 15 0	0 14 0	0 14 3	0 14 3	0 14 0	0 14 0	0 15 0	0 14 3	0 15 3	0 14 8
1898	0 15 0	0 14 4	0 14 9	0 14 6	0 15 0	0 15 0	0 14 0	0 14 0	0 14 9	0 14 9	0 15 0	0 14 9	0 14 7
1899	0 15 0	0 15 3	0 15 6	0 15 6	0 15 9	0 16 0	0 17 6	0 18 0	0 17 9	0 18 0	0 19 0	1 0 0	0 16 11½
1900	1 1 0	1 0 6	1 1 0	1 0 9	1 1 0	1 1 0	1 1 3	1 1 6	1 1 3	1 1 3	1 0 0	0 18 0	1 0 8½
1901	0 17 6	0 16 0	0 15 0	0 14 6	0 15 6	0 15 9	0 14 9	0 15 3	0 15 9	0 15 9	0 15 9	0 15 9	0 15 7½
1902	0 15 6	0 15 0	0 16 0	0 16 0	0 15 6	0 15 3	0 15 6	0 16 0	0 16 0	0 16 0	0 15 9	0 15 0	0 15 8½
1903	0 15 6	0 16 0	0 16 6	0 16 3	0 16 3	0 16 10	0 15 9	0 15 6	0 15 6	0 14 9	0 14 9	0 15 1	0 15 8
1904	0 14 9	0 15 3	0 15 1	0 15 4	0 15 3	0 15 0	0 14 5	0 14 6	0 14 6	0 14 6	0 14 6	0 14 7	0 14 9½
1905	0 15 3	0 15 6	0 15 0	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 16 6	0 18 6	0 18 9	0 18 9	0 16 3½
1906	1 0 0	1 1 6	1 0 0	1 0 0	0 19 6	1 0 0	0 19 6	0 19 4	1 0 6	1 1 6	1 1 9	1 3 6	1 0 7
1907	1 3 6	1 2 6	1 2 6	1 2 0	1 1 6	1 2 3	1 2 3	1 [illegible] 0	1 1 0	0 19 0	0 18 9	0 17 6	1 1 2½
1908	0 16 6	0 15 0	0 15 6	0 15 6	0 15 3	0 15 0	0 15 0	0 14 9	0 15 0	0 16 0	0 16 0	0 16 0	0 15 8½
1909	0 15 9	0 16 3	0 16 0	0 16 0	0 16 3	0 16 6	0 16 0	0 16 0	0 17 0	0 17 0	0 17 6	0 17 6	0 16 6
1910	1 0 4	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 3	1 0 3	1 0 6½	1 1 3	1 1 3	1 0 9½
1911	1 2 2½	1 2 6	1 2 6	1 1 11½	1 · 11½	0 19 6	0 19 0	0 19 0	0 19 1½	0 19 6	1 0 0½	1 1 6½	1 0 7½
1912	1 2 3	1 2 6	1 2 6	1 1 1½	1 1 6	1 1 6	1 1 6	1 2 3	1 2 6	1 3 0	1 3 0	1 2 11	1 2 2½
1913	1 2 9	1 2 2	1 1 7½	1 1 6	1 0 8½	1 0 0	1 0 0	1 0 0	0 19 10½	0 19 1½	0 19 0	0 19 0	1 0 3½
1914	0 18 7½	0 18 0	0 18 0	0 17 9	0 17 6	0 17 6	0 17 1½	0 19 7½	0 18 11½	0 17 10½	0 18 7½	1 1 0½	0 18 3½
1915	1 7 7½	1 8 6	1 9 3	1 10 2½	1 8 6	1 6 4	1 5 10½	1 6 0	1 6 10½	1 10 8½	1 13 0	1 17 10	1 9 1½
1916	1 18 6	2 0 1½	2 2 6½	2 0 6½	1 15 0	1 16 3	1 18 0	1 18 0	1 18 0	—	—	—	—
1917	} Price Fixed												
1918													
1919	—	—	—	—	2 5 7½	2 14 4½	2 16 4½	2 14 0	2 13 4½	2 13 0	2 12 7½	2 11 9	—
1920	2 17 0	3 7 9	2 15 6	3 6 7	3 0 0	2 15 0	2 14 0	2 9 9	2 7 6	2 11 0	2 12 3	2 10 0	2 15 0
1921	2 1 0	2 0 1½	1 18 3	1 17 6	1 17 6	1 17 6	1 17 6	1 5 0	1 8 9½	1 7 9	1 7 0	1 7 0	1 13 8½
1922	1 6 7½	1 5 10½	1 6 11	1 7 0	1 7 0	1 7 0	1 5 3	1 4 9½	1 4 2½	1 3 3½	1 2 6	1 2 3	1 5 2½
1923	1 2 9½	1 4 6½	1 5 2	1 4 8½	1 4 6	1 4 0	1 3 6	1 3 0	1 3 0	1 3 0	1 3 2½	1 4 9	1 3 10½
1924	1 4 2½	1 4 0	1 4 0	1 3 7½	1 3 8½	1 3 6	1 2 11	1 2 6	1 2 1½	1 1 7½	1 2 3	1 2 6	1 3 1
1925	1 2 6	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 6	1 0 6	1 0 0	1 0 0	1 0 0	1 0 3	1 0 10½	1 1 1½
1926	1 1 1½	1 1 6	1 1 6	1 1 3½	1 1 3	1 1 5½	1 1 6	1 1 6	1 1 0	1 1 6	1 1 6	—	1 1 4½
1927	1 2 1½	1 2 3	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 7½	1 1 0	1 1 0	1 1 0	1 1 0	1 1 0	1 1 7½
1928	1 1 0	1 1 1½	1 1 11	1 2 4½	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 6	1 2 2½
1929	1 2 6	1 2 6½	1 2 11½	1 3 0	1 3 0	1 3 2½	1 4 0	1 4 8½	1 4 7½	1 4 6	1 4 6	1 4 3	1 3 7½
1930	1 3 3½	1 2 6	1 1 9	1 1 6	1 0 10½	1 0 0	1 0 0	0 19 6	0 19 0	0 17 4½	0 16 4½	0 16 4½	0 19 10½
1931	0 16 1½	0 16 0	0 16 0	0 15 11½	0 15 4½	0 15 0½	0 14 10½	0 14 6	0 14 3½	0 14 6	0 16 8½	0 17 0½	0 16 6
1932	0 16 6	0 16 6	0 16 3	0 15 6	0 15 4½	0 15 0	0 14 11	0 14 8½	0 14 6	0 14 6	0 14 9	0 15 1	0 15 9
1933	0 15 6	0 15 3	0 15 3	0 15 3	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 15 11½	0 16 6	0 16 6	0 15 3½
1934	0 16 6	0 17 6	0 16 9	0 16 6½	0 16 8½	0 16 9½	0 17 0	0 17 0	0 17 0	0 17 0	0 17 0	0 17 0	0 15 7½
1935	0 17 0	0 17 4½	0 17 6	0 17 6	0 17 6	0 17 6	0 17 6	0 17 6	0 17 6	0 17 7½	0 18 0	0 18 0	0 16 10½
1936	0 18 0	0 18 3½	0 18 6½	0 18 9	0 18 9	0 19 0½	1 0 0	1 0 4½	1 0 6	1 0 6	—	—	0 17 6½
													0 19 3½*

* Average for the ten months.

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EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

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'Phone: 287 SLOUGH

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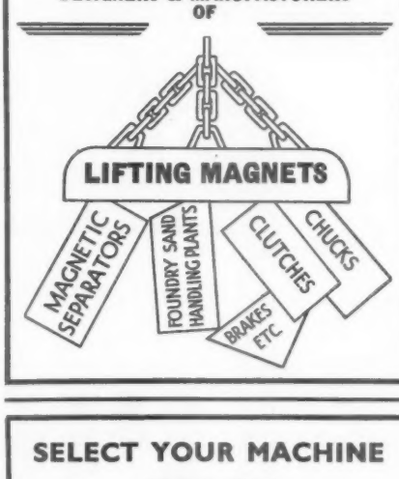

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